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THE

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ELECTRICAL POWER DISTRIBUTION.

IN the present Session several Bills seeking powers to distribute electrical energy over large industrial areas will again come before Parliament.

Probably the most important of these is that of the Lancashire Electric Power Company, which seeks powers for the county of Lancashire south of the River Ribble, while others relate to the Glamorganshire coal fields of South Wales, the Tyneside manufacturing district, and an area in the North of London embracing portions of the counties of Middelesex and Hertfordshire.

The principle underlying these proposals is of such importance to the electrical industry that it is worth while to get a clear understanding of it. It forms part of the broad issue of municipal trading *versus* private enterprise, a subject which is deservedly securing an increasing amount of attention, and of which the roots lie deep in the social and economic theories which have become prevalent in Great Britain during the last quarter of a century.

The industrial position of electrical science in this country having been determined in a very large measure by these theories, it is of importance that the fullest possible light should be thrown upon the whole subject in order that we may determine how far the result has been beneficial, by comparison with the development of the electrical industry in other countries.

It will be remembered that last year several power distribution Bills were brought forward, but collapsed at the standing orders stage, with the exception of that of the General Power Distributing Company, which was keenly debated in the House of Commons on second reading.

All these Bills sought permissive powers to furnish a supply of electrical energy throughout their areas, irrespective of whether local authorities or others in particular districts might hold existing powers, or be already furnishing a supply.

The Bill was thrown out, on what grounds it is difficult to say; but probably because Parliament did not thoroughly understand the issue, and Members were largely influenced by pressure from the municipal corporations to reject the measure *in toto*.

Recognising the present reluctance of Parliament to take any step in opposition to the wishes of local authorities, the Bills now about to be introduced have made the important concession of confining supply only to such districts within their areas as the local authorities may be willing for them to enter; and the only compulsory power sought is the right to carry mains through a non-consenting district in order to reach a consenting district beyond.

Local authorities are, in every case, to have their reasonable convenience consulted as to where the undertakers' mains shall be laid, so as to guard against undue interference with the streets; and they are further to have the option of taking a supply "in bulk," and of undertaking the work

of local distribution themselves, so that if they so desire they can thus remain the sole source of supply for their own district.

These concessions were doubtless framed by the promoters of the present Bills in the belief that they would thereby avert all opposition on the part of local authorities, and satisfy the scruples of Parliament.

It will be seen that not only does no question of "monopoly" for the undertakers arise in the Bills, but the undertakers do not even ask for powers to disturb the monopoly now enjoyed by the local authorities who have established their own works. Under these circumstances it might have been supposed that no opposition would be threatened to the Bills by public bodies whose position is thus assured—an opposition which can only have the effect of depriving of the advantages of cheap electrical energy others who may be genuinely desirous of securing them.

It is regrettable to record, however, that this is apparently not to be the attitude of many of the local authorities concerned. As stated in our last issue, a meeting of representatives of municipal corporations affected by the Lancashire Electric Power Bill was held at Manchester last week, when the matter was considered, and resolutions hostile to the Bill were carried by general assent. The speakers were evidently sorely put to it to suggest to the meeting any plausible grounds of objection, and being apparently unable to adduce sound arguments, they took refuge in appeals to the prejudice and ignorance which unfortunately still largely prevail among our parochial Bumbles and Dogberrys.

Alderman Higginbottom, from whose honourable antecedents in the field of electrical enterprise better things might have been looked for, is reported to have said :—

"Some doubt was, perhaps, raised as to whether municipal authorities ought to oppose the Bill or not. As far as Manchester was concerned the Corporation had instructed its Committee to oppose at every stage of the Bill."

As a pretext for this procedure the speaker proceeds to suggest :—

"Supposing a private company had a main going through their streets with a pressure of 10,000 volts, from which the Corporation got no benefit whatever, if they had a short circuit or a blow-up, who was to decide whether it was in the Corporation or the company's mains ?"

When it is borne in mind that the promoters of the Bill undertake to consult the reasonable convenience of the local authorities as to where their mains shall be placed, it is difficult to take either the speaker or the audience, which apparently received the objection with approval, seriously.

A subsequent speaker, Alderman Petrie, of Liverpool, is reported to have said :—

"The members of the Lancashire Corporations ought, if necessary, to tell Parliamentary representatives that unless they opposed the Bills as strenuously as possible, they would themselves be opposed by their constituents."

This frank exposition of municipal tyranny throws a light upon the attitude of local authorities towards these measures which it is sincerely to be hoped will not escape the observation of the many intelligent and independent members of Parliament who, we feel assured, are not prepared to be cowed into prostitution of their birthright of honest judgment by the threats of officials and vestrymen who are either ignorant or prejudiced in regard to the great issues on which they are called upon to arbitrate.

It is to be deplored that while in America, Germany, and Switzerland, these great projects of electrical science are flourishing, to the unquestionable advantage of the public, under the healthy stimulus of free competition and private enterprise—as at Niagara, Rheinfelden, Geneva, and many other places—we appear destined by the will of Parliament and the cramping fetters of parochial government to see this country left further and further behind in regard to one of the most widely beneficial industrial developments of the century.

Many of the municipal corporations represented at the meeting have electrical engineers in their service. It would be interesting to know whether the latter have been consulted on the Bill, as they should have been. If so, it is difficult to understand the senseless arguments advanced at the meeting against it. If not, we venture to urge that it is the duty of the electrical engineers concerned—a duty alike to themselves and to their profession—to disassociate themselves from the narrow-minded attitude of men whose horizon appears bounded by considerations of local exigency and petty ambition, to the exclusion of liberal progress in the interests of their fellows and neighbours.

THE ELECTRICAL UNITS.

In another column we print an explanation of a proposal recently made by Prof. Fessenden, and developed by Prof. Fleming, for changes in the electrical units. As a matter of fact, three separate questions of very different importance are involved in these proposals. They are the questions of the fundamental units, of the commercial units, and of nomenclature.

The original definitions adopted by the British Association Committee are statements in carefully selected terms of the results of experiment, and no change can be made in the essence of the equations except on the ground of fresh experimental results. The form, however, of the equations can be varied indefinitely by changing the language employed, and is determined by considerations of convenience, the principal object being to express as directly as possible the known relations of the quantities to one another and to the general scheme of things. The last condition is apt to vary greatly with the state of knowledge, and electricians recognise that the present forms of the equations obscure to some extent the real relations between the quantities as they are now conceived. A slightly different set of statements of the same results was proposed by Mr. Heaviside, and called by him "rational," and now a new set comes from Prof. Fessenden. Whether either of these can be looked on as being final in the absence of any accepted theory of electrical action is somewhat doubtful.

Prof. Fleming gives a very clear statement of the fundamental relations as now understood, and argues implicitly that these are unlikely to require modification. This view receives support from hydro-dynamics, where the results are inevitably stated in a mode precisely analogous to that employed by electricians.

The question of the practical units is simpler but vastly more important. The value of a system of measurement depends on its wide, if not universal, employment, and the better this condition is satisfied the more troublesome is any alteration. It is this which has imposed the Roman acre, and the pole, furlong, and mile, the basis of an ancient and obsolete system of agriculture, on our land measurements, and for smaller lengths has given us an entirely different system. In consequence of the wide-spread use of the old pound, the demi-kilo is the unit for small weights instead of the kilogramme in metrical countries, and the decimal system has been powerless to effect the use of the dozen and the gross. Our present electrical units are now universal, and form perhaps the only system of measurement of any kind of which this can be said. Prof. Fleming now suggests that the ohm, the ampere, the watt, and the microfarad should each be multiplied or divided by 10, with the object of simplifying the relations between the fundamental and the derived units, and meets the objection that the change will be troublesome, by pointing out how little it will be necessary for the instrument maker to do. It is, however, just such a change as this that will cause the greatest confusion and the most troublesome mistakes. If the unit were to be multiplied by 10,000, or by 4π, so that the size or the character of the resulting figures were entirely altered, mistakes would be less likely: but a movement of the decimal point by one figure made in one direction when measuring current, and in the other direction when measuring resistance, would be excessively confusing not only in actual work but in referring to previous records. If Prof. Fleming and electrical students find a difficulty in remembering that the volt is 10^8 units, while the ohm is 10^9 units, let them think of the difficulty for a working lad testing copper wire in a factory, or for a workman wiring a house, in remembering that all his currents are 10 times less than they used to be, and his resistances 10 times as great. In a large concern very serious losses may be incurred by mistakes of the kind that this change would make likely. It is well that proposals of all kinds should be considered, and Prof. Fleming's are ingenious and interesting, but the advantage to be gained from such a change as he suggests is excessively small compared with the inconvenience caused to the world. The change of the ohm and the volt some years ago was troublesome enough, but it was a change of complicated figures. Labour was incurred, and is still, but little confusion or mistake.

Prof. Fessenden's ingenious proposal seems useful and unobjectionable. It gives a perfect system of "rational" equations such as philosophers desire, does not touch the practical engineer, and gives simple relations between the two systems of units. It is curious that the two changes in the meanings of terms employed by Prof. Fessenden were not only independently proposed many years ago, but actually printed together, while it was left for him to see that the combination of the two gave a valuable result, the possibility of which does not seem to have been contemplated.

The last point connected with the change of units, the nomenclature, is a much more open question. A system of names that would indicate the relations between the fundamental and derived units would certainly be useful. Any very simple system seems, however, to require that the powers of 10 to be used should be few, and proposals we have recently noticed on the point involve changes in the commercial units to effect this. There is, however, plenty of room for ingenuity in devising names for existing systems but no mere simplification of nomenclature would now justify an alteration of the commercial units.

Electrical science is being rapidly organised. The growth of the Institution of Electrical Engineers, the publication of *Science Abstracts*, the National Laboratory, the new University of London, are all powerful means of ascertaining and bringing into accord the opinions of all kinds of men on such subjects as the present, and if a change is about to be made, there is every reason to hope that it will be wise and permanent.

Alternating Current Curves.—Seefehlner has devised an ingenious method of drawing the current curves of an alternator, though his apparatus as yet appears to be somewhat complicated. Apparatus for showing the form of the current curve, or the E.M.F. curve of an alternator, in which a highly sensitive galvanometer and revolving mirror are made use of, have already been constructed, and have given remarkably good results. But when the frequency of the cycles of current, &c., exceeds a certain limit, the inertia of the movable part of the galvanometer becomes a disturbing factor that cannot be neglected, and vitiates the results. What we want is an indicator of current, or E.M.F., which is practically free from inertia, and this we possess in the beam of cathode rays. This beam, as is well known, can be deflected by a magnetic field cutting it at right angles, and the deflection is proportional to the strength of the magnetic field. Braun has devised a cathode ray tube specially adapted for these measurements (see *Wied. Ann.*, Vol. 60, p. 552). Near the middle of this tube there is an aluminium diaphragm with a small aperture, which allows a thin pencil of the cathode rays to pass through and fall upon a phosphorescent screen. It is this pencil which is subjected to the action of the magnetic field. The magnetic field is preferably produced by a solenoid, to avoid the disturbing effects of an iron core. If the solenoid is placed in the circuit of an alternator, the phosphorescent spot on the screen will move to and fro in a straight line *pari passu* with the current. To show the shape of the curve on the screen it is necessary to deflect the beam at right angles by a uniformly increasing current, and this is what Seefehlner has done. He has devised several methods of obtaining this uniformly increasing current. One method may be represented by saying that the two branches of a Wheatstone bridge form the two halves of a rotating ring. Two fixed brushes rubbing on this ring, at opposite ends of a diameter, will evidently take off uniformly decreasing and increasing currents, which may be used to feed a solenoid at right angles to the first solenoid. Further details of Seefehlner's apparatus will be found in the *Zeitschrift f. Elektrotechnik*, 18, p. 5.

The Cost of Power in Country Houses.—From an estimate of Mr. Gordon Harris, made upon the cost of pumping 1,000 gallons of water 100 feet by various powers, we obtain the following figures:—

1.	Hand labour at 18s. per week	26·5 pence.
2.	Horse-power and man at 18s.	4·20 „
3.	Gas engine and pump, gas at 4s. per 1,000 cubic feet	1·44 „
4.	Small steam pump and boiler, coal at £1	0·75 „
5.	Oil engine and pump, oil at 7d.	0·70 „
6.	Electrically-driven pump worked from a lighting dynamo	0·45 „

from which it would appear that electricity may be by far the cheapest power. Much, of course, depends on circumstances. Hand power may be the cheapest in some cases, especially when the power may be that of some pensioner who must be kept, and is happier when he feels he earns his keep. The horse-power ought not to be saddled with the cost of the man, for a horse becomes automatic and does not call for attention. We are not informed how much expense for attendance is allowed in the steam and gas or oil engine, but it is obvious that where the average country house is concerned, there may be many circumstances to bar the application of modern methods and machines.

LEGAL.

RUCKER *v.* THE LONDON ELECTRIC SUPPLY CORPORATION, LIMITED.

(*Continued from page* 139.)

THIRD DAY—WEDNESDAY, JANUARY 24TH.

THE trial of this action was resumed on Wednesday, when Mr. Swinburne was further cross-examined by Mr. Fletcher Moulton.

WITNESS was referred to the opening paragraph of the specification, which runs as follows:—"For some time past induction coils consisting of two coils of layers of insulated copper wires with a common iron core similar to the Ruhmkorff apparatus, have been used for the transformation of alternating electric currents. By means of such transformation electric energy can be cheaply conveyed over lines of considerable length, and be utilised in a number of local circuits for lighting and other purposes."

MR. FLETCHER MOULTON: That, of course, is put in by the patentee as being matter of common knowledge, not as part of his invention?—Yes, that was common knowledge.

So that sending currents through the primary coil of the transformer and using the secondary was known?—Yes.

I do not know what you say was known regarding transformers. There are no directions given in this patent with regard to manufacture?—No.

And when you were going to use circuits in parallel you liked low internal resistance?—Other things being equal, low resistance was preferable.

Was there enough knowledge to enable transformers to be made?—Oh, transformers were known before then—since 1882.

And made to produce any effect desired?—I won't say "any effect desired," but they were produced.

But was there enough knowledge to make a transformer which would produce a desired result?—Yes, I think so.

There was. The effect of a transformer is to transform, up or down, the tension of the circuit?—Yes.

If I may put it so, it either increases or diminishes, in a certain proportion depending on the transformers, the tension of the circuit?—Yes, or leaves it as it was.

And a transformer is an instrument for that purpose, and was known?—Yes.

And there was a well-known rule of thumb, namely, ratio of turns?—No, that was not known.

Now, I just want to cite against you the authority of Mr. James Swinburne.—All right.

You remember the Gaulard and Gibbs litigation?—Yes. I was a witness in it, and gave my evidence in July, 1888.

And I had the pleasure of cross-examining you on that occasion?—That is so.

MR. FLETCHER MOULTON then read several questions and answers put and given in the Gaulard and Gibbs trial to show that it went in contradiction to Mr. Swinburne's present evidence as to the state of knowledge prior to 1885, and to show further that the witness had stated that the rule of thumb had been known as far back as 1882. Having read the passage, Mr. Fletcher Moulton asked:—Speaking in 1888, you say you think this was old, it must have been, and older than 1882?—Yes.

And now you say it is later than 1885?—Yes. The question asked me in 1888 was asked not so much as regarded transformers, but induction, and I made a slip there, and what is more remarkable, Lord Kelvin did so also.

But the whole of that evidence was treating the transformer as an induction coil?—So far as it did that, it was wrong; it was far from accurate. I do not think that the relation between the pressure and the number of turns was understood in 1883.

Well, having got a known instrument, which would raise, multiply, or divide the tension of a current, go back to the customer with the poles in his house. He could make a circuit for himself?—Yes, he could make what was wanted.

So that my legislatively protected customer, though obliged to take the supply of energy at the potential prescribed, could then divide it if he liked?—Yes.

And that was known at the time?—It could have been done if anybody had wanted it.

In reply to a remark from his LORDSHIP,

MR. FLETCHER MOULTON said that the witness had surprised him by saying that nobody would then put an induction coil across the poles of a parallel main, and he wanted to point out that at the time, induction coils were used with even higher power than that.

WITNESS said that what he meant was that the only electric light induction coils extant in practical engineering at the time were those of Gaulard and Gibbs. If one of their coils in use in 1885 were taken, it could be used without alteration for this invention.

MR. FLETCHER MOULTON then referred witness to an article in the *Times* describing Fuller's invention, prior to the patent now in question. Fuller's invention, the article stated, involved an alternating current in parallel distribution with induction coils. (To witness)—There, Fuller proposed to have induction coils with their primaries in multiple arc?—No, not in multiple arc, but in series.

And in this patent it is proposed to have a series of induction coils also put across the poles?—Yes.

Therefore I may take it that parallel distribution taken off at any house by means of primary coils across the mains was not new.—No, it was not new.

We have got it, that it was not new to tap parallel mains by a transformer whose primary was in multiple arc?—It was not new to propose it.

While the secondary circuit was utilised?—Yes, while it was utilised, or proposed to be utilised. But they were not practically useful proposals which had then been made.

I am not on the point of whether they were commercially useless if they chose to go from high to low tension—People understood transformers, but they did not understand the difficulties.

On a question of the meaning of high and low tension, MR. MOULTON said they might take the simile of water. (To Witness): A small waterfall of great height might be as good as a large waterfall of lesser height?—Yes.

If you send electricity at low pressure you require to have large conductors but weak insulation?—Yes.

If you send electricity at very high pressure, you require small conductors, but strong insulation?—Yes.

And in any case the proper tension in practice is got by balancing the cost of conductor against the cost of insulation?—Yes; I take it as you say.

And all that was known long ago—in 1878, or before that?—Yes.

Supposing your generating station was a long distance from the place where you desire to use the electricity, you would have your pressure as high as practicable?—Yes.

On the other hand, where you are utilising specially in a small area, the increased convenience and safety of low pressure make you inclined towards low pressure?—Yes.

I have used the words high or low as if they had some absolute meaning. The real fact is, it is a question of higher or lower. You always have to choose that in which you get the best economical results of balancing the cost of conductors against the cost of insulation. For instance, supposing you are distributing, say, throughout a very large building, large enough to make the conductors of considerable cost, you might distribute, we will say, at 1,000 volts, and then drop down to 200 or 100.—Yes; but 1,000 is very largely used.

On the other hand, if you are going to send the electricity 30 miles, you would probably consider 1,000 volts as very low, and send at 20,000, and then drop down?—Yes, that is what the defendants do; so that all this question of high and low is comparative.

That idea of economy by long distance at high pressure, and of convenience by short distance at low pressure is a very important rule of practice in electric distribution?—Oh, yes.

But that is not due to this patentee. It was known before his patent?—The desirability was certainly known.

It had been proposed to do it—to transform up in order to send electricity at high tension and to transform down to use it at low pressure?—Yes; as I have said, it had been thought of. It had been perfectly recognised.

In further cross-examination, WITNESS said he was aware that Edison was a strong partisan of the direct current. He thought Edison never had a patent for distribution of alternating currents. But Edison realised that they could transform down an alternating current, and also that a low tension current would be suitable for lamps in parallel. Witness was then referred to an article in a French technical paper describing a prior discovery.

What is there in this patent other than what is in that article?—Nothing that I can think of.

Witness was then referred to an article in the ELECTRICAL REVIEW of June 9th, 1883, by Mr. Rankin Kennedy on "Secondary Generators." Mr. Fletcher Moulton said it was very important. In that article the writer said:—"Having some experience in working a system of my own for producing lights in vacuo by means of secondary currents, I should wish to notice a few interesting experiments which go far to show the economy or non-economy of such currents applied to lighting. I shall, therefore, simply describe the experiments; the results speak for themselves. In the first case I used a Siemens alternate current dynamo with its exciter. This was coupled up direct through 10 or 12 Maxim lamps, and through a large induction coil, so that all the current passed first through the lamps, then through the primary wire of the induction coil. This induction coil had a movable core, and when the dynamo was started, and the current turned on for the first experiment the core was out of the coil altogether. The Maxim lamps were then brilliantly incandescent. The speed of the dynamo was now taken, and found to be 700 revolutions per minute. Now the core of the coil was inserted gradually into the coil, and as more and more of the core entered the coil the incandescence of the Maxim lamps became less and less, until finally, when all the core was in its place the Maxim lamps gave no light at all, yet the dynamo still ran at 700 per minute."

That was acting as a choking coil, was it not?—Yes.

The back electromotive force produced by the action of the current itself actually stopped the action of the current?—Yes.

And that effect of the current on itself was all known and worked out 15 years before this?—The induction of coils was known, but Dr. Hopkinson was the first to point out the property of choking coils.

MR. MOULTON went on to read the article: "The insertion of the core evidently set up a counter E.M.F. to the E.M.F. of the dynamo, and thus reduced the current," and so on.

WITNESS: But the law as to choking coils was not known The laws of mutual induction of coils were. Dr. Hopkinson published it first in 1885.

After quoting further from the article,

MR. MOULTON said that the writer told them that if they closed the secondary circuit, instead of the Maxim lamps giving no light at all, they became brilliantly incandescent.—Yes.

MR. MOULTON (continuing to quote): "The next experiment was to join the ends of the secondary wire. In the first experiment the secondary wire had been idle; but in this second experiment everything remained the same as in fig. 1, the core being out, and the ends of the secondary wire joined directly together. On running the dynamo now at 700, the Maxim lamps were again brilliantly incandescent, and on introducing the core, they were but very slightly

reduced in brilliancy. Evidently the joining of the secondary wire terminals had a powerful effect, as was shown to be the case upon breaking the secondary circuit, when the Maxim lamps became a dull red, giving no light, and thus by merely making the secondary circuit, I could turn up the light to brilliancy, and by breaking the secondary circuit I could turn the lights down to a dull red." (To witness): So that that article told the world, if the world did not know it before, that you could stop a current going through a primary by having a secondary opened?—Yes; or that you could reduce it very much.

Mr. MOULTON read on: "This experiment shows very clearly the action of secondary generators, and beautifully illustrates the fact that secondary generators have a counter E.M.F. set up in their primary circuit, and that the secondary currents generated in the secondary wire of such generators in their turn neutralise this counter E.M.F. Now, these phenomena indicate a vast objection, or, rather, obstacle, in the way of the distribution of electric light by secondary generators, because, although the main current is beyond the reach of the hand, or of any instrument, it can be reduced to nothing, or increased to its maximum, without in any way interfering with the wires or coils conveying it. Suppose a series of seven secondary generators in series, an alternate dynamo sends currents through the primary wires of each generator and all the secondary wires to be open circuit, in this case the counter E.M.F. would be so great that very little current would pass through the series. Now join up generator secondary wire, *a*, so that the induced current goes through and lights, say, three Swan lamps, the current in the whole circuit will be increased, because the counter E.M.F. due to the generator will be neutralised by the secondary current now flowing in its secondary wire. Now join up the secondary circuit, *b*, through three Swan lamps, the current in the whole primary circuit will again be increased, because the counter E.M.F. of *b* will now be neutralised, and so on. Every generator's secondary circuit, on being closed, would affect current in all the others, and this without any metallic or other connection whatever between the several secondary wires or between the secondary and primary wires. In parallel arc, however, the secondary generator is a beautiful self-governing system of distribution, but what about the size of conductors for such a system? Prodigious!"—Mr. MOULTON (to witness): That shows the disadvantage of using secondary generators in series?—Yes.

Turning to the plaintiff's complete specification, Mr. MOULTON reading said:—"For some time past induction coils consisting of two coils of the layers of insulated copper wire with a common iron core similar to the Ruhmkorff apparatus, had been used for the transformation of alternating electric currents. By means of such transformation electric energy can be cheaply conveyed over lines of considerable length, and be utilised in a number of local circuits for lighting and other purposes. The distribution of electrical energy by such means, has, however, not succeeded in such a manner as to satisfy the requirements of every day practice, because it was not possible to increase or diminish the number of points of consumption in operation, without affecting the working of the others in a marked degree, and it was therefore necessary to use mechanically acting regulating devices at the different points of consumption to compensate for the variations caused by the changes in quantity of electrical energy used."—(To the witness): Now Mr. Swinburne, that refers to Gaulard and Gibbs?—Yes.

Now Gaulard and Gibbs required a special form of circuit, and things were put on in series?—Yes; it is not that they required it, but they used it.

Now in the case of transformers in parallel. They can be put on an ordinary parallel system?—Yes.

The consumer could put one on?—Yes; I have got one at my house.

Mr. MOULTON (reading from the specification): "Now the object of this invention is to make all individual points of consumption of electrical energy quite independent from one another, all necessary regulations being made by or at the generator of electricity. We group the induction coils or transformers so as to constitute secondary distributing stations or local centres." (To the witness.) Do you consider that to be an essential part of the patent?—It is not essential. It is not confined to sub-station distribution, but to transformers in a house, for instance.

Mr. MOULTON (reading): "The primary coils of the several transformers of such a local centre may be arranged either in series or in multiple arc circuits." (To witness.) The "series" refers to transformers in series?—Yes.

Mr. MOULTON: "In the former case the secondary or induced spires of all the transformers of the respective stations form a single local circuit irrespective of whether these induced spires are connected up in quantity or in series. In the second case, however, viz, when the primary coils of the several transformers constituting a local centre are connected up in multiple arc, either each individual induced coil may form a separate secondary circuit, or any number, or all of the induced coils of the transformers of a local centre may be connected to form a single local circuit." (To the witness.) That would include the case of a single transformer and a single secondary circuit?—The witness said he could not agree with that suggestion. The plaintiff's invention was for transformers used in a particular way on a system of distribution.

Mr. MOULTON, addressing his Lordship, said one of his defences was that there was nothing in the plaintiff's specification to patent. If a man told you how to judiciously use a thing, that could not be the subject matter of a patent.

His LORDSHIP said he could not see the learned counsel's point.

In further cross-examination by Mr. MOULTON on the complete specification, the WITNESS said it was perfectly well known that with induction coils or transformers you could transform either up or down.

I believe the words high tension and low tension do not occur in the provisional specification at all?—No, it appears not.

And they do not occur in the claim?—No.

Supposing a man wanted a high tension alternating current, and he put transformers on his poles and transformed up and put his lamps which required a high tension in parallel. Is that within the patent?—No, I should not think it was.

Transforming up and transforming down were both equally well known?—Yes.

The dangers of high tension and of low tension in connection with conductors of certain lengths were well known?—Yes.

Now it had been pointed out before this patent that it was advisable to send for long distances at high tension?—Yes.

And to send at high tension for the purpose of turning to low tension?—Yes.

Mr. MOULTON, reading from the specification: "Now, the electromotive forces of the two coils of a transformer bear a constant ratio to one another." (To the witness): Do you suggest that that is put forward by the patentees as being their discovery?

The WITNESS: No, I do not think it is; I think it was their discovery, but I do not think they realised it.

Further cross-examined, the WITNESS said that what the inventors claimed was a scientific arrangement of the transformers to solve the distribution question.

In what respects do you say we infringe?—In that you have a system of distribution with transformers with alternating currents, with high tension primaries coupled in parallel, on about 2,400 volts, and secondaries supplying lamps, the lamps being in parallel on 100 volts.

And do you consider the high tension of the main and the low tension of the consumption circuit both essential?—Yes.

We send at 10,000 volts from Deptford and transform down to 2,400. What do you call these?—They are both high tension.

Mr. BOUSFIELD: But we do not know at present whether what is sent from Deptford is all transformed by one transformer which brings it down to 2,400, or whether there is a series of transformers.

Mr. MOULTON: I do not care whether it is by 1 or 20. I want to know whether it is within the patent or not. (To witness): Do you tell his Lordship that the electricians of 1885 did not know that a machine which was sending out current, that was transformed down, would work if you kept it at the constant potential?—They knew it would work if kept at the constant potential, but they did not know that in certain circumstances it would keep the constant potential.

Mr. Bousfield had begun the re-examination of the witness when the Court adjourned for the day.

FOURTH DAY, THURSDAY, JANUARY 25TH.

On Thursday Mr. JAMES SWINBURNE was re-examined with the view of showing that the plaintiff's patent contained novelties not embraced in Fuller's invention or in Mr. Rankin Kennedy's experiments, which he had described in his paper in the ELECTRICAL REVIEW of June 9th, 1883. Referring to Edison's specification, witness said that no sound-minded electrician would have adopted it for purposes of distribution. There was nothing in it to show that it was necessary, as in the case of the plaintiff's patent, to have a low resistance transformer in order to succeed. There had been great discussions in the electrical world as to distribution and the size of the mains, but in 1885 it had settled down to the question of direct current distribution. The object was to get a system that would serve a bigger area but would need reduced weight of copper in doing it.

Mr. BOUSFIELD: In Mr. Rankin Kennedy's paper it is said, "The insertion of the core evidently set up a counter E.M.F. to the E.M.F. of the dynamo, and thus reduced the current." He is right qualitatively there?—Yes.

But had he any quantitative ideas on the subject, so far as you could see from his article?—No; and there is no indication of the lamps being parallel, and no indication of the necessity for low resistance. He was obviously not so far as that.

Mr. JAMES KENNETH DOUGLAS MACKENZIE was next called. The witness is about to proceed to America, and was called to give rebutting evidence on a point which, it was anticipated, would be put forward in defence.

Examined by Mr. BOUSFIELD, WITNESS said he was a general engineer, but he had formerly been an electrical engineer, and practical electrical engineer to the Metropolitan Company. In 1882 he met Messrs. Gaulard and Gibbs, and became acquainted with their system. They wanted him to take up their system at that time. In 1883 there was an electrical exhibition at the Royal Aquarium. Gaulard and Gibbs were showing something there, and witness went thoroughly into it. Mr. Gaulard himself explained it to him, and he helped Mr. Gaulard to carry on his work. There was an article in the ELECTRICAL REVIEW of April 21st, 1883, which described the apparatus shown at the Royal Aquarium. It described the two instruments exhibited, and gave an accurate description of them. Witness was associated with the making of the arrangements for lighting the Grosvenor Gallery by electricity. The installation was completed in March or April, 1885. They used 20 or 25 H.P. engines.

Mr. BOUSFIELD: When did it occur to you to make the Gallery a distributing station from which to supply other people with electricity?—It was about Christmas, 1884, or the beginning of 1885, and that required a much larger installation. The idea at first was to put down a couple of 100 H.P., but afterwards it was much increased. They did not cease using the Gallery as a distributing station till the latter part of 1885.

It is suggested that prior to the specification in this case this system was somehow being used at Valleries' premises in connection with the Grosvenor Gallery installation. Was it possible

for Valleries to be connected with the Gallery before the date of this specification?—Oh, unquestionably no.

Cross-examined by Mr. MOULTON, WITNESS said he had gone to the Royal Aquarium when the exhibition was opened about the beginning of 1883, and he entered the employment of Gaulard and Gibbs, when their company was formed. The company was formed about June, 1883. At that time there was an installation at the Aquarium, but only for the months during which the exhibition was running. After the closing of the exhibition, so far as he knew, Gaulard and Gibbs' system was not used at the Aquarium. After they lighted the Grosvenor Gallery they supplied current to neighbouring houses. He did not think Valleries were the first consumers, and they could not come on till quite the end of 1885. There was a Mr. Fesquet, an electrician in the service of Gaulard and Gibbs. Witness did not think that Fesquet was at the Aquarium. He did not recollect seeing Fesquet until well after the Grosvenor Gallery was under weigh. Fesquet had nothing to do with the installation at the Aquarium; but he assisted at the Grosvenor Gallery in the beginning of 1886. In that year, Gaulard and Gibbs undertook to supply transformers at the Grosvenor Gallery, and Fesquet was their manager for that work. Witness started the Metropolitan Railway installation with Mr. Gaulard about the end of September, 1883.

Mr. W. M. MORDEY, electrical engineer, examined by Mr. BOUSFIELD, said his practical work with transformers for distribution began in 1886. With the exception of Gaulard and Gibbs, no one had done anything practical with transformers before 1886. He had kept himself practically acquainted with all that was being done to solve the question of distribution, and he was familiar with the history of transformers from the time they were first suggested as a means of distribution, and even further back than that. At the date of this patent there was the low tension system of Edison, which was admirable for small areas, but was not practicable for large ones. A number of people were trying to work out systems for high tension supply. The only successful attempt to get the advantages of high tension for large areas was the series system. It was the only practical high tension system. Electrical engineers were, at the time, on the *qui vive* to find out a system giving high tension distribution and low tension supply. Gaulard and Gibbs were working in that direction. Practical engineers, however, looked almost with contempt at that time on the work then being done. Even when it was proposed by the plaintiff's system to solve the question of high tension distribution and low tension supply by the use of parallel arc lamps, it was not generally accepted. Alternating currents were not understood at the time at all, and engineers did not think any practical solution would be attained by alternating currents. That was one reason why Gaulard and Gibbs' attempts were looked upon unfavourably. Their system carried them no further in the direction of the fundamental requirement of regulation. It gave no control of individual lamps, and therefore it was condemned, and the condemnation still held good. It was not effective where they had an indefinite number of lamps on or off. There was nothing in the article in *La Lumière Electrique*, of October 11th, 1884, to enable electricians to suppose that the use of transformers, whether Gaulard and Gibbs or any other, would be helpful in solving the problem of distribution. With regard to the article describing the invention shown at the Vienna Exhibition, it was true that the article set out the fundamental requirements of an installation, and it said that the exhibit fulfilled those requirements; but it did not show how. The means employed to arrive at the results were not given, and an electrical engineer would not, by that article, be enabled to understand the plaintiff's methods of distribution. The defendants sent a large force of electricity from Deptford, and at Trafalgar Square they had a number of transformers in parallel, and the lamp connections were in parallel. He could not distinguish between their system and that described in the plaintiff's specification.

In cross-examination by Mr. FLETCHER MOULTON, WITNESS said that it might have been in 1885 that transforming down alternating currents from one tension to another was common knowledge; but it certainly was not common practice. As to the question of infringement, the defendants sent up from Deptford a current at 10,000 volts high tension for the purpose of transmission.

Mr. MOULTON: And M. Deprez proposed that?—Yes.

And the only difference is that we supply more than one transformer?—Yes.

Supposing we had one single transformer and one single station here, that would be M. Deprez?—Yes.

Then you don't rely on the part that transforms from 10,000 to 2,400 volts?—No. The 2,400 was a new circuit, and from that they transformed again. In transforming down many transformers were used, and as the demand fell they banked down the number. It was self-regulating, but for the purpose of saving energy they could be switched off.

In re-examination by Mr. BOUSFIELD, WITNESS said that as long ago as Faraday it was known that if they had two wires passing side by side at a given distance, the inductive effect depended on the length of the wires and the distance between them. With a large transformer, they required a considerable length of wire in one coil; with a small transformer they required a number of smaller coils. In his opinion there was no necessity for the patentee in 1885 to instruct a workman that the amount of induction he would get would depend upon the length of his wires. He was a workman in that sense, and he began to make this transformer in 1886, and had no difficulty in doing so.

Mr. BOUSFIELD: In the particulars of objection there is this passage:—"No invention was required to design a transformer which would choke with an open secondary circuit." Is that so?—Knowledge was required which did not exist. What I mean is, transformers were in existence which would choke with a secondary current; but I know no case where it is clear that that was realised.

You mean to say that choking more or less exists in any transformer?—Yes, but it was not realised that that quality could be utilised in the way proposed by the patent. The article in the *Times* about Fuller's invention would not have enabled anyone, with the then existing knowledge, to arrive at the results secured under this patent.

In the original, unamended specification, do you see any signs, taking it as it stood with the original claims, of any want of good faith or reasonable skill and knowledge?—No; I think it shows great skill and knowledge.

Mr. MOULTON: The part struck out related to means for supplying an alternating electric current of a tension as constant as possible?—Yes.

This closed the plaintiff's case; and the Court adjourned for the day.

FIFTH DAY, FRIDAY, JANUARY 26TH.

The hearing of the action was resumed on Friday, when Mr. FLETCHER MOULTON opened the case for the defence. He said that this was a very remarkable litigation. His learned friend Mr. Bousfield had been defending a patent which had been worked broadcast all over the country by half the electric lighting companies in existence, and that for several years. Yet the action was brought only in the last few months of the life of the patent, and this action was being tried after the patent had expired. That made the case a somewhat unusual one. Mr. Bousfield had made excuses on the ground of the litigation abroad. These stood simply on counsel's statement, and were not relevant at all. Mr. Bousfield had no right to refer to that litigation.

His LORDSHIP: He has not proved it.

Mr. MOULTON said no; and, after all, the statement was incorrect. But even if it were correct, it did not alter the situation in the least. They had to go back 14 years in the history of electric distribution; and his Lordship had now before him not the results of what was done at the commencement of those 14 years, but the results of the matured thought and of the gradual development which had been going on during all those years. It doubtless would add to his Lordship's difficulty that he had to go back from the present adult stage of a great industry to what was almost its infant stage; and his learned friend depended on that. He had asked the Court to note the developments, and to see how many of them were on the lines to which this patent referred. He, legitimately, claimed to strengthen his case in that way. But the Court would be very careful as to that matter, and in going back to the infant stage of a great industry, would be careful to distinguish between what was invention and what was merely the realisation of something that was already known. His Lordship would note this. People did not commence an industry of this kind until there was an accumulation of knowledge promising so much that they could step from the individual sporadic use of the means at disposal to large schemes of combined action. That accumulation of knowledge, applied to the new circumstances, would produce striking new results; but it did not follow that there had been one atom of invention in producing those new results. It might simply be that that knowledge, working on a small scale, had now the opportunity of working on a large scale, and that the results were due to no new invention, no new knowledge, but simply to the power of applying the existing knowledge to new means and new circumstances. The change produced by this change of field was most marked when they went back to the infancy of an industry of this kind. The contrast between a year before and a year afterward was so great, that they were inclined to speak of those years as years of great invention. As a rule, however, they were only years of great development. The old knowledge had been pent up in narrow limits for its exercise. Most of the development was due to the change of circumstances, and not to change of discovery, and that was a consideration which he (Mr. Fletcher Moulton) was legitimately entitled to impress upon his Lordship's mind. Electricity had been studied at the date of the patent on a more or less large scale for many years. Its real development had been due to a large extent to Faraday between the years 1830 and 1850, and its laws were thoroughly known. If they went to a book he doubted very much whether they would find one which would take higher rank than one which he himself (Mr. Moulton) had studied at college, by Clark Maxwell; and all the mathematical intellects, and the intellects of the cultivated world had been working out electricity on an accumulated knowledge so thorough and complete, that it formed a science by itself. But its practical use, except in such a thing as plating, where it was indispensable, was small, because the main sources of it were chemical, and came from a battery, and those methods were expensive on any large scale of action. But then the great change came by the discovery in 1871, or thereabouts, of the dynamo machine, by which the work previously done could be produced by mechanical means. Gramme was one of the first to discover it, and his patent was sent out from beleaguered Paris by pigeon-post in 1870. This was a new step, which enabled them to get from an engine a large amount of energy, and which showed to man that electricity could be made to go between the engine, the source of power, and any other appliance. At the same time that they discovered that they could get electricity from mechanical power, they also found that they could get mechanical power from electricity, and thereupon electricity took its position in the world as a great means of transmission of power, and as a form of power which could be produced in any quantity, and at a rate which depended simply on the cost of coal. Thereupon the question arose—Can it produce light cheaply? and the arc light which had its disadvantages, of course, because of its heat, but which was wonderfully cheap—attracted attention. In 1877 and 1878 that light was beginning to take an important position in industrial work. For large spaces they were admitted to be the finest lights, and were

received into stations and all sorts of places, doing a work which they still did, and work which it was admitted was very important. At the same time Edison and Swan—and both of them deserve the credit of it—gave a much more manageable light by the incandescent lamp. From 1876 onwards they worked at that, and in 1878 Edison brought out his incandescent lamp, just about a week before the Swan was patented in England. When the lamp, which required a certain pressure to work it, and which therefore put a straddle between different conductors to work it, with the advantage that if you turned one light out the others continued to receive the supply, was devised, then there was initiated the idea of electrical distribution. He used the word "initiated" carefully. He (Mr. Fletcher Moulton) denied that it was an invention. What it amounted to was this, that what one could do in his room was so important that other people, who had not the skill or the means of doing it in their own rooms, would say—We will do it by combined action. So that when it was suggested that there should be lines through a town kept at certain tensions, going through each house at certain tensions, so that the people could put their lamps across these lines in multiple arc, it was not an invention, but something that Edison and others had already done. He (Mr. Fletcher Moulton) would refer to the analogy of water. In olden times each householder provided himself with water, but to get it to the top of the house he pumped it up through the different storeys. But the supply of water was so important that it led to the construction of waterworks. They did the pumping. The works were constructed in some neighbouring hills. The water was delivered at a certain pressure to each of the houses, and there was no invention in that. The suggestion that a town should be supplied in that way was an excellent piece of advice, but it had no connection with invention. It gave every man a pipe into his house in which the water was under pressure. It obliged the man to pay water rates, and in return for those he was allowed to use the water. Suppose a man had said, "Oh, I will take out a patent for supplying water to the upper storeys; you used to pump up to the upper storeys, but I will take a pipe up and so provide supply to the upper storeys" What would be the answer to any application for a patent for that? It would be that this was intended to be done by water under pressure, and that it was no invention to do that with water under pressure which was being supplied in that house. There was no novelty unless they changed the source of power. If the Court would bear that analogy in mind, he would pass from water to electricity; for if he were right in what he had said, then this case was a very simple one, and rested on questions which had very little to do with electricity in itself, although they were fundamental to the question of invention. When Edison found that there was a use so universal in its application—the incandescent light, which required constant pressure—he then set to work with the view of laying on electricity for the community at constant pressure, just as water had been laid on at constant pressure. That was not an invention. It was found when application was made in 1881 to the Legislature for powers to inaugurate this kind of distribution that that question—whether the need was a public one of sufficient importance—was a question which had to be looked into, and in 1882 the Legislature decided that it was; and in that year the Legislature laid down certain rules in regard to it which admirably showed what the then state of knowledge was as to distribution. The important thing that they laid down was this. They said that they would not allow any company to control the use of electricity; that they did not know what future uses might be invented which might be largely for the good of the public; that the only thing they contemplated was electrical energy, so that as water was sent into houses so electrical energy might be sent into houses in such way as that every individual might have it under his own control just as he had the water under his own control, and that Parliament would not allow any company to interfere with that control. That showed that the knowledge of that day was such that it was perfectly recognised, that by generating stations you could give supplies of electrical energy just as you could give supplies of water; and, therefore, the analogy between water and electricity held good to that extent. That was all that Parliament would permit; and that was a general act. It did not go into the question of how the thing could be done, but it did say: "If you cannot deliver as energy, if you have to deliver as light, we do not give you power; we give you liberty to deliver energy." But in the following year, on the demand of an immense number of applicants—showing the amount of attention given to it—the Legislature had to force the problem of how they could arrange that the energy could be supplied. It had to be supplied in a way which would leave it open to any man to use it as he liked; and what Edison had been exhorting was so obviously the right thing that the Legislature specially recognised that as a possible way of supplying energy, so that a man could himself use it as he liked, and in provisional orders under the Electric Lighting Act they made detailed regulations. What did they decide? They did not confine themselves to saying what systems might be used. They mentioned two systems, and any other that they might approve; but the only one they worked out carefully was Edison's idea of distributing electricity at a definite pressure just as water was distributed at a definite pressure. They worked that out most completely, and they stipulated that if a person chose that method, then he must undertake that at two poles in a customer's house there should be a pressure which should be what was called a standard pressure, and the company was not to ask what the customer did beyond those poles. Now how could he draw it off? He could only draw it off by straddling. It was a felony to do it in any other way. That was in the knowledge of the time, and was quite rightly recognised as being the supply of electrical energy which left the customer free to use it as he liked, the electricity being taken by straddle at those two poles. Thus there was this new source of electrical energy installed throughout a town, and everybody had a right to look upon those two poles as being a machine giving electrical energy at that potential. He (Mr. Fletcher Moulton) would submit with the greatest confidence to the Court that there was not, and could not be, any invention for using those two poles for any purpose for which an electrical machine had been used before. He might call it a new statutory machine. If they had to get an invention, they had to get a machine to drive it. It could not be suggested that to put a motor on the two poles was an invention. It was using a new source, because until the statutory powers had been given these things did not exist; but these things came into existence and were legislated for merely as sources of electrical energy. He submitted to the Court that the then position of distribution in electrical knowledge cut out distribution absolutely from being an element of invention. They had to start behind their poles if they were to have an invention. Let his Lordship see what that meant. These transformers—if he might put it so—were dead things. They could only work from a source of electric energy. But it was said that the poles were never thought of as a source of alternating current at constant pressure. So little was that true that both were separately legislated for in 1883. The alternating current was recognised as the cheaper, although not so cheap for plating uses, and it could not be used in those days because continuous current was required. The consequence was that continuous current was first treated, and was rather petted because it was felt to be more generally useful. But the alternating current, being cheaper to make and more useful for other things, was separately legislated for and separately described. Well, these transformers had been used with alternating machines, and put on the poles of such machines; and so they had got their statutory alternating machine and put their transformers upon it. Where was the invention? They had only used a different alternating machine. Yet here came this patentee, and said, "Oh, people did not do this before." Very well; but people did not have this statutory machine. Faraday had not a statutory machine in his own laboratory; nor had other people Gramme's machine until Gramme invented it. So that, down to that point, he would submit that there was no invention, and that this was a claim for drawing off electrical energy simply by straddling transformers over the main, and that the attempt to drag in something more was not in the claim. But what did the plaintiff say beyond that? They said, "Yes; but we put on our lamps in parallel in the secondary." In reply, he (Mr. Fletcher Moulton) would say that the plaintiff's claim was not only for electric lighting but for any purpose, and could they say that putting lamps in parallel on a circuit was going to be held for 14 years? They said that it was the secondary circuit of an induction coil; but one of their own witnesses had told the Court that that was the way they were put on by Gaulard and Gibbs years before. To tell him (Mr. Fletcher Moulton) that he was not to use his secondary circuit, which there was no invention in getting, for any purpose he liked, for sending the current through a group of lamps, appeared to him ludicrous. But the plaintiff said: "I told you it was much wiser to use it in this way." To tell him that was not an invention. Where was the invention? He (Mr. Fletcher Moulton) had the right to use the secondary current for any purpose he wanted. The plaintiff said that he must not put lamps in parallel. Why? The plaintiff also claimed the position of the transformer. But that claim was impossible, for machines in that position were contemplated by the Legislature, and legislation was the most conclusive evidence of common knowledge. Therefore he submitted that there was no invention in this case. There was nothing original. An induction coil had always been a thing which multiplied up the tension in the primary circuit, or divided it down; that was transforming up or down. Mr. Fletcher Moulton quoted from the evidence on the question of common knowledge, in 1885, of instruments that would raise or lower the tension, to show that they were known, and that the legislative customer could make his own circuit at whatever tension he pleased. The plaintiff had relied on the words "system of distribution." But system of distribution was simply scale, and scale did not make a patent. If a man could do this thing in his own house with half a dozen lamps, it might be multiplied a hundred times, but they did not get nearer an invention. If merely to do a thing on a large scale would render a patent valid, then company promoters would be the greatest inventors in the world. To assert that the mains were to be high pressure, and the transformers low pressure, was merely to state scale of pressures. If the standard pressure was allowed to be 10,000 volts by the Board of Trade, they could turn it lower in certain lamps. If it could be said that this patentee pointed out for the first time the advantage of saving copper by distribution at high tension, there would be something in this claim, but Edison and Deprez both had pointed out that it was best to distribute at high pressure. So that, taking into account the then knowledge of machines, the defendants were only using known machines, which were in known use and in known ways, and the then knowledge was such that they were only using them for their ordinary purposes. The witnesses on the other side had admitted that the drawing off from parallel mains and using the current in the secondary was old. Both Mr. Swinburne and Mr. Mordey had admitted that to be old, and yet that was the real invention claimed in the specification. The shortest way to describe that to an electrician would be to give him Brush's fig. 9. One saw at once how he meant to keep the tension constant by the way in which he arranged his parallel mains. That showed the purpose to which he was applying himself.

His LORDSHIP: Does an incandescent lamp require an alternating current?

Mr. FLETCHER MOULTON said that it was equally good with either. Why in the world should it not be used for a group of incandescent lamps? Nobody could say that there was any invention in substituting it. The plaintiff said that any fool could have substituted it, but that he would not have known how good it was. That was all that the plaintiff's witnesses could say. Could anyone say, "Mr. Smith, you shall not put lamps in parallel on that circuit, because you

never did know how successful it would be." When Brush showed one even you could not limit it. They could do what they liked with the appliances which science had given to them. It was no answer to say that it would be a great success if they used it in one way, and not a success if they used it in another way. A new use for an old thing was not subject matter for a patent. Here they had the very thing applied to arc lights. That was suitable for incandescent lamps—why should it not be put on if it was suitable for incandescent lamps, and why not for a group of lamps? It seemed to him (Mr. Fletcher Moulton) that Brush told everything. The answer was that at the time that Brush wrote people were ignorant. There must be novelty in a patent. He was told that Mr. Brush thought of working with a constant current machine, but he (Mr. Fletcher Moulton) did not see that, because Brush said his lamp could be used for alternating machines or not. That seemed to him absolutely fatal. Referring to Fuller's article in the *Times*, Mr. Fletcher Moulton said that Fuller told his intelligent readers how to arrange their mains. It was admitted that what Fuller told them was parallel distribution. They tried to say that if you looked at the particular formation it would be seen to be a bad one. It would be seen that this was a general method of doing it, and the next matter he would touch upon was Edison, which was, in his view, exceedingly important. Edison did all that the patentee in the present case did, and more. What Edison did "more" was very difficult, but Edison did it fairly, and the witnesses who would be called on behalf of the defendants would say that this "more" would have succeeded. But beyond the "more," which might have encountered difficulties, Edison, as he should submit, did all that the patentees in the present case did. Edison was always a great enthusiast for the continuous current. He wanted to get the advantage of distributing at high tension, but he had not a machine which would transform down a continuous current. Edison said, "I want to transform down, but I cannot do so because I have no instrument which transforms down with continuous current; I must make it into alternating." And he produced a high tension alternating with a low tension, so that he did all that the plaintiff did, and more.

His LORDSHIP: Was the effect of this that he transformed down?

Mr. MOULTON: Yes.

His LORDSHIP: And was he successful?

Mr. MOULTON: Oh, absolutely. And the important thing is, that when he has transformed down, he treats it as an incandescent light circuit of constant pressure, and he puts his lamps in parallel. His submission was that Edison did all that was in the plaintiff's specification, and more. The transforming down and using in parallel were all to be found in Edison. It could not be said that putting lamps in parallel on the secondary of transformers which transformed down was novel. What the patentees claimed was that they had invented a system by which the tension was made as constant as possible. In the circumstances that looked like a general claim, and his submission was that it was bad. It could not be said that it was novel to put incandescent lamps on the secondary of transformers which transformed down. If that was not novel, why should not a man take a transformer which transformed down, and put it in parallel on his poles. Then it was said that putting lamps in parallel was of the essence of the invention. If a man chose to use his two poles as a source, he had the right to do so. As soon as they got the tension of the circuit constant, they were exactly in the same position as if they had an alternating machine, which always gave them a current of constant tension. The moment they realised that a man had got a right to use his current, and used it by a known instrument, and fitted a circuit from that, he could use it for anything he chose. He could not see how that could add to the patentable character of the thing. The plaintiff seemed to put it thus:—That a man would not have known that putting on more lamps would not spoil the light of the others. Well, all he (Mr. Fletcher Moulton) could say was that he would soon have learnt it. Realising the result of arrangement, when there was no novelty in the arrangement, was not patentable. It was a new doctrine to him that judicial cognisance was to be taken of English electricians as being more ignorant than those of other countries. Edison showed them the high tension constant and the low tension constant, and he did not think it necessary to tell English engineers that there was a constant relation between them. Deprez unquestionably treated it as a thing of common knowledge. It was only when the thing came into Court that Zipernowsky and Déri told the world everything. Apart from this there were books written on the subject, and the rights of the public were not based on the suggestions of people to learn the knowledge which existed. Mr. Fletcher Moulton then read and commented on the plaintiff's complete specification. Referring to the passage "but the distinctive feature of our system of distribution is that each group of induction coils or transformers of the several stations of second order shall merely constitute branch circuits of the main line for the primary current, viz., the primary circuits of the several local centres, any one of these being taken as a whole, are connected in multiple arc," he said the patentees might have said that the distinctive feature was admitted to be Brush's fig. 9. A man did not get a patent because a curious phenomenon took place.

At the close of his speech Mr. FLETCHER MOULTON called evidence for the defence.

Lord KELVIN was the first witness called. In answer to Mr. FLETCHER MOULTON, he said he had taken great interest in all economic developments of electricity during his lifetime. He remembered the first Electric Lighting Act in 1882. At that time the idea of distributing electricity was very prominently before the public mind. The ordinary method of distribution proposed was called parallel distribution by alternating currents, and was actually carried into effect in 1882 in the Health Exhibition and at Cambridge. The characteristic of distribution in parallel was that the tension at the poles remained constant, or as constant as could conveniently be had. A transformer was not a new name for an induction coil. It was a name about 17 years old. It was known that induction coils would transform up or down, he thought, in the years 1850 or 1860—certainly long before 1885. The laws of induction were known and calculations made from them by Maxwell in 1868, and by electricians ever since. There was nothing with regard to the behaviour of induction coils that was known now that was not known in 1868. Improvements had been made on the very earliest induction coils, especially on the subdivision of the coil—that was made certainly before 1870. Of course there had been improvements according to the new needs, but those were improvements in design, but not in principle. At the date of the patent, or before, if a man wanted to multiply up the tension of alternating current, it was known how to do it, also how to multiply down. Speaking of Brush's fig. 9, Lord Kelvin stated that there was no novelty in substituting for an arc lamp 10 ordinary incandescent lamps, such as were used in 1882, in parallel. The incandescent lamps were not known at the time of Brush's specification. The only lamp known was the arc lamp. Fuller had done all that the plaintiff claimed to do. Edison also did what the patentees in the present case did, and more. The fact of transformers being put across the poles was known before the date of the plaintiff's specification.

Mr. FLETCHER MOULTON: Would it be known that that would multiply either up or down the tension of the circuit?—Perfectly well known.

Mr. MOULTON: Was there any novelty, then, in the consumer getting a circuit of a different tension to his primary?—No.

Do you find anything in this specification which, in your opinion, was novel at that date?—It may have been novel in the sense of not being generally known, but not novel to a person with scientific knowledge. Any person who was versed in Edison or Fuller would know that there was nothing novel in it.

At this stage the further hearing was adjourned until Monday.

The hearing was continued on Monday, Tuesday and Wednesday this week. Lord Kelvin was re-examined by Mr. Bousfield at great length, and evidence was also given by M. Emile Fesquet, Mr. S. Z. de Ferranti, and Mr. E. Collins of the Patent Office library. Mr. Fletcher Moulton, on Tuesday afternoon, commenced his summing up for the defence, which also occupied Wednesday's sitting. The Court adjourned until Thursday.

MESSRS. TURNER & SONS *v.* BRINSMEAD.

IN the Queen's Bench Division of the High Court of Justice on Tuesday, January 23rd, the hearing was resumed before Mr. Justice Mathew, sitting with Prof. A. B. W. Kennedy as assessor, of the action in which Messrs. John Turner & Sons, of Denton, Manchester, electrical engineers, sued Mr. Thomas James Brinsmead, of London, to recover from the defendant £260, alleged to be due under contract for the supply of an electric automatic lift to some flats then in course of erection at Maitland Park, Haverstock Hill, London, N.W. Defendant counterclaimed, and set out in defence that plaintiffs agreed on November 1st and 3rd, 1897, to construct the lift according to their specification, the whole work and material to be of the best description and quality, completion to be by February 1st, 1898, to the satisfaction of defendant's consulting engineer, and the officials of St. Pancras Vestry, and of the inspector of the Insurance Company. Defendant pleaded that the lift was not completed by the contract date or within a reasonable time, that it had not been completed up to November, 1898, that it was defective both in design and construction, dangerous as well as useless, and could not be passed. On January 23rd, 1899, defendant notified plaintiffs to remove it, but as that was not done, he removed it himself and employed another contractor. Defendant's counterclaim, which amounted in the total to £868 8s., included £515 17s. for the supply of a new lift by the Otis Elevator Company, exclusive of cage and Bostwick gates.

Mr. Bousfield, Q.C., and Mr. Neill, instructed by Messrs. Richards and Hurst, solicitors, of Ashton-under-Lyne, appeared for the plaintiffs; and Mr. Jelf, Q.C., and Mr. J. Eldon Bankes, instructed by M. Muskett, for the defendant.

The case came on originally on the 11th ult., the opening day of the Hilary Sittings, when the learned judge suggested the desirability of his having a scientific gentleman associated with him as assessor, and this being agreed to, Prof. Kennedy was selected by consent of the parties.

On the 23rd ult. the evidence in support of the counterclaim was first heard.

Mr. ROBERT A. SMITH, consulting engineer, who had examined the plaintiffs' lift on March 3rd, 1898, gave a detailed criticism of the apparatus. Witness found the speed of the winding drum comparatively slow; that of the motor was high, and in consequence gearing had to be used. When the lift was still the motor was at rest, and some mode of starting was required. The whole idea of the lift was automatic. In working, the passenger had to press buttons. One button had to be pressed to bring the lift to the floor at which the passenger was waiting, and another to mark the floor to which he wished to be taken, and on reaching that floor a gate automatically opened, but that gate could not be opened unless the lift was behind it. On the passenger going into the lift, he pressed another button, which set the lift in motion. Witness saw no indicators to show which buttons had to be pressed. The passenger had to find out whether the lift was above or below him. There was apparatus placed on each floor, which could be worked from any floor,

and the apparatus connected with the buttons was in the basement. A pendulum switch regulated the direction in which the lift was to travel, and this pendulum swung to each side according to the button pressed, and on swinging in that manner it came into contact with pieces of metal. In his (Mr. Smith's) opinion, that was not a good idea, as the pendulum was likely to stick, and had only the force of gravitation to bring it back to the perpendicular. When the pendulum came into contact with those side pieces of metal, it sent a current through a pilot motor, which worked other apparatus and also started the larger motor. The apparatus of which the pendulum formed a part leaned against the wall at a considerable angle, and that was not proper. Witness considered the voltage—200—too low. He did not consider that the part of the apparatus just described would work for more than a few times. The winding drums were 6 inches in diameter, which was too small for the size of the ropes; the diameter should have been 78 inches. There were no grooves on the drums, which witness regarded as dangerous, the ropes being ⅝-inch diameter. Witness didn't think that if the ropes broke the apparatus for arresting the progress of the lift would have any effect whatever; it was an iron instrument supported by a cord. If the ropes broke, the lift going down would break that cord, and it was assumed that the iron would then drop, and the other end, being sharpened, would fix itself into the wooden runners. But witness did not think that would be the case in action, because the iron would only enter one side of the runner, and broken out by the weight of the lift. If there were another piece on that apparatus, so that it would grip the runner on two sides, it might succeed; but under the conditions he saw, witness did not consider there was absolutely any protection for human life, or against fire or dust, and the whole thing was exceedingly fragile.

Mr. Morgan Williams, another expert, who had made three inspections of the lift, endorsed the views of the previous witness, with whom he entirely agreed. The lift was liable to overrun, owing to the fact that wooden pulleys were used. The lift had to him (Mr. Williams) the appearance of a laboratory experiment. He regarded the design as exceedingly clever and ingenious, but he thought the apparatus altogether too fragile for practical use.

Mr. C. F. Quicke, defendant's consulting engineer, having given corroborative evidence,

Mr. Francis A. Wilkinson, inspector to the St. Pancras Vestry, deposed to an examination of the lift, which he made along with Mr. Quicke, on November 15th, 1898. They moved the pendulum to one side with a pencil, and the lift rose to the roof of the building and jammed there. Witness then left.

Mr. Brinsmead, the defendant, said he wished to open the buildings in March, 1898, and desired to advertise the lift as well. This he was unable to do, and he had to employ another contractor.

The hearing was then adjourned until the next day.

At the resumed hearing on Wednesday, the 24th inst.,

Mr. George Aveyard, plaintiffs' electrical engineer, said that he designed the lift in dispute, and saw it erected. His firm had met several of the objections which the defendant made to the apparatus. There were a number of trials of the lift, and it worked satisfactorily. Witness was present at defendant's trial on November 15th, and Brinsmead appeared satisfied and accepted the lift. When first tested in September, the brake magnet went wrong through damp, and that trial could not be carried out. Mr. Quick approved of several details in connection with the brake; he also said he thought a good job had been made, but that some parts were too strong. Having explained the working of the pendulum switch, by means of the apparatus itself, witness said he did not agree with Mr. Smith that the springs would have no effect because one would counteract the other. No one had ever called his (witness's) attention to defects in the materials used; only the best materials were procured. After the lift had jammed in the roof, he asked defendant for particulars of any defects, but none were supplied. Witness had made several trials of the safety apparatus for use if the lift ropes broke, and the apparatus worked quite well and arrested the progress of the falling lift within 4 inches. He had seen other lifts fitted with similar clutches. He did not think it possible for the pendulum switch to stick as had been suggested, as only a small current—about a quarter of an ampere—was passing.

Mr. John Hewett, practising as consulting engineer, and consulting engineer to the Corporation of Chatham, who examined the lift in January, 1899, in company with the previous witness, said it then worked very well, stopping within 1 inch or 1½ inches of the proper levels. It was a very clever design, and one which witness considered quite practical. The general workmanship was good, though there were little things which might have been improved. He saw no reason why contacts of the pendulum switch should stick, and there would have been no difficulty in putting in carbon instead of metal, but the addition of another magnet would be required to make the pressure sufficient to ensure good contact. The main motor worked very well.

Cross-examined, he had had personal experience of these lifts. He had had no practical experience of a pendulum reversing switch such as this. If he had been in the engineer's position, he would have made the thrust bearing with a larger surface. The box of black grease for lubrication was rather a rough device, and, except in crane work, witness had never seen such an arrangement.

Mr. Albert Turner, one of the plaintiffs, said that in July, 1898, he was at the defendant's flats, and saw the lift working. It was not then finished, and the wheels made a little noise; otherwise, the lift worked as witness expected. Defendant complained about the vibration, and it was decided to remove the wheels and put the motor direct on to the drum shaft. Witness saw the test on November 15th, when the lift worked very satisfactorily. Brinsmead's only comment was that it seemed rather slow, but as regarded the starting and stopping, he was satisfied with everything. The contract speed was 30 feet, and that was the speed of the lift. That which defendant had in now was 90 feet. After November 15th he (plaintiff) did not see Brinsmead at all. Mr. Quick, acting as defendant's consulting engineer, for a year or a year and a half acted as the London agent for witness's firm, but they were not satisfied with the volume of business, and gave notice to terminate the arrangement.

Mr. Henry Herbert Turner, another of the plaintiffs, said that the only objection raised to the lift was that it was unreliable. His firm offered, and was always ready, to remedy any defects under their contract.

Several of plaintiffs' workmen engaged in the erection of the lift and who had been present at the tests, deposed to the lift working very satisfactorily at all the trials.

Mr. Chas. Bayman, who had been caretaker at the defendant's flats, said that on November 15th the lift worked very well. Witness, his wife, and his little girl, worked it, and it never failed to work at any time. After November 15th the fuses were handed to witness by Mr. Aveyard.

Cross-examined: He should imagine the lift went up hundreds of times, but he never had permission to allow any of the tenants to use it.

The evidence being concluded, his Lordship said he thought it would be a convenient course that he should have the assistance of the Assessor's views on the technical questions, each side could then be informed of the result, and the rest of the case might thereafter be discussed before him (the Judge) without requiring Prof. Kennedy to attend again.

Mr. J. Eldon Bankes said he was quite content to leave the technical question on the evidence, as it stood, for the consideration of the Assessor.

It was accordingly arranged that an opportunity should be afforded Prof. Kennedy of inspecting the various portions of the lift which had been dealt with in the course of the trial; and Mr. Neill, on behalf of the plaintiffs, agreed to the course.

The further hearing stood adjourned.

Western and Brazilian Telegraph Company, Limited, *v.* South American Cable Company, Limited.

Mr. Justice Kennedy had this case before him in the Queen's Bench Division on Tuesday.

Mr. Lawson Walton, Q.C., and Mr. Bankes, appeared for the plaintiffs, and Mr. Joseph Walton, Q.C., and Mr. Scrutton, for the defendants.

Mr. Walton said the action was brought to recover £475, being the balance due upon an account in respect of the interchange of telegrams between the months of January, 1895, and September, 1898. The plaintiffs' claimed that under the true construction of an agreement between themselves and the defendants, by means of which telegraphic traffic was to be interchanged, this sum was due. The defence, as he understood, was that the agreement had been wrongly construed, and that under the true construction of the arrangement, there was a balance on the account due to defendants. The main question to be determined was the true construction of the agreement. The plaintiff company was registered in 1873, and about the same period the Brazilian Submarine Company, Limited, was formed. The plaintiff company had its cables constructed along the coast of Brazil, starting at Pernambuco and connected with other ports to the north and south. In that way Pernambuco on the north was connected with Monte Video on the south. It was a marine cable, and was therefore independent of the local internal lines of telegraphic communication which were the property of the various Governments through which they passed. The Brazilian and Submarine Telegraph Company had cables passing from London to Lisbon through Madeira, Cape Verde Islands to Pernambuco. A telegram from London to Monte Video had thus first to pass to Pernambuco by the Brazilian Submarine Company, and then to Monte Video by the plaintiffs' cables. For some years there was an interchange agreement under which they divided between them the rates up to Pernambuco, and thence onwards to the destination of the message. That arrangement led to a good deal of friction from time to time. There were practical difficulties in adjusting the questions between them, and ultimately, in 1889, they went into partnership. They made a pooling agreement. The whole of the traffic of the two companies was put into one pool, and the profits divided in the ratio of 54 to 46, the Submarine Company taking 54 per cent., and the plaintiff company 46 per cent. This state of things existed from 1889 to 1893, but in 1891 a new factor was introduced into the Trans-Atlantic and Submarine Telegraph system by the construction of a new cable. Prior to the year 1891 there was a cable connecting Cadiz, in Spain, with Teneriffe and Senegal in French West Africa, and in 1891 the defendant company projected a new inter-ocean cable connecting Senegal with Pernambuco. They were registered in the same year as the South American Cable Company, Limited, and thereafter there were two alternative routes to South America. The defendant company, however, had no line to Monte Video, which was the chief port to which cables were sent, and their agent at Pernambuco had for a few days to despatch the messages from there to their destinations over the plaintiff company's system at ordinary rates. The plaintiff company, however, decided not to take any more of these messages, and for a considerable period there was no connection whatever between the plaintiffs' system and the defendant company, who, however, sought to bring about an arrangement, and ultimately this was effected. It was necessary first of all to arrive at a partition between the rate for the carriage of cables to Pernambuco and the rate from Pernambuco to the different ports on the plaintiffs' system. Hitherto, owing to the arrangement between the plaintiffs and the

Submarine Company, that partition was practically determined, but if the plaintiffs were to allow to the defendants the right of delivering their cables to Pernambuco, and to undertake to carry these cables to places on their system, it was necessary to know what was the rate to Pernambuco and from there to the different places on the system, and that partition was the basis of somewhat extensive negotiation between the two parties and the Berne Convention, and the defendants were given to understand that the rates charged would be based on a calculation with reference to the existing interchange between the Submarine Company and the plaintiffs. The proportion, which was originally 46 and 54, had been altered to 48 and 52. In December, 1893, a contract was sent to the defendants, and it was intimated that if they used the services of the plaintiff company it would be at the rate of 3·02 francs per word for Pernambuco to the different stations mentioned, and on December 29th defendants accepted the proposal, and had utilised the lines ever since. Although they grumbled that they were not properly treated, they had not terminated the agreement, which they had a right to do at any time. Defendants had no enjoyment of the receipts from the local traffic, and there was a sort of intimation that they did not accept the plaintiffs' assurance that the proportion of 48 and 52 was really the proportion applicable to their rate. In February, 1895, it was intimated to them that the arrangement was confined entirely to international traffic. There was no reply to the letter, and the defendants practically accepted that position by continuing to send their cables. Defendants some considerable time afterwards asserted that they were entitled to be partners in all the local business of the plaintiff company, and suggested a resort to arbitration. On November 26th, 1897, plaintiffs set out the full account, showing a balance for the March and June quarters in their favour, and repeating the terms on which they had carried defendants' traffic in the past, and stating that they were the only terms on which they would carry it for the future. No reply was received. The balance stood at £475 19s. 1d. Defendants refused to pay, and by their counterclaim they asked that the account should be made out on some new basis which would credit them with a larger proportion of this interchange of traffic, so as to liquidate the amount claimed and leave a large balance in their favour.

Mr. JOSEPH WALTON said his case was that the plaintiffs' charges for delivery of messages from Pernambuco were not 48 per cent., and there was no word in the agreement which indicated that. It was a vain delusion to go through the form of dividing this up as between the plaintiff company and the Submarine, because that was not what they did at all. They each got a certain share of the common fund. The agreement between the plaintiffs and the Submarine Company did not deal with through messages separately. It provided for a certain allowance to each, in respect of that which each contributed. Leaving out the local traffic on the eastern side, what the Submarine contributed was the service to Pernambuco. What it got paid was a sum which was measured by taking 52 per cent. of something which was put into the common purse. What the plaintiffs allowed was not 52 per cent. of the receipts of the through traffic, but that 52 per cent. plus something more.

The JUDGE: I suppose it is correct that, if there are three sets of remunerative work done between the two companies, first the purely local traffic of the plaintiffs, secondly the purely local traffic of the Submarine, and thirdly the Oceanic traffic; in regard to each of these taken separately for the year 48 per cent. is the proportion taken by one and 52 by the other.

Mr. J. WALTON said that would be so, but the local traffic on the American side was put in only by the plaintiff company. The through messages were earned by both. Of course, if the defendants had committed themselves to the figures mentioned, there was an end of the case; but they had not. The contract was that they should get the same proportion in respect of what they did as the Submarine got for what it did. The figures of 52 and 48 had no relation to mileage, or to the rates charged. There was no allocation of figures in the contract. What defendants claimed was to be treated as the Submarine was treated.

His LORDSHIP said, though there was a good deal to be said for the defendants' contention, yet he was clearly of opinion that the plaintiffs were right in their construction of the contract. The arrangement only referred to international traffic, and did not admit the defendants to the advantages of the pooling agreement with the Submarine Company. He must give judgment for the plaintiffs on the claim and the counterclaim with costs.

CORRESPONDENCE.

"Inductor" Alternators.

Referring to the illustrated article in your last issue on the Leicester Corporation Electricity Works, I fail to see why you call the alternators there described "inductor machines." These machines do not in any way answer to the definition given by such an authority as Prof. Silvanus P. Thompson in his patent of 1883, where he says, "In my improved machines the field magnets, however excited, are fixed, the armature coils are also fixed. Instead of rotating these I rotate between them inductors, which may consist partly of iron or other magnetic material and partly of non-magnetic or of non-metallic matter."

These inductors, he goes on to say, "are during their rotation magnetised by passing near the poles of the field magnets and thus made to act inductively upon the armature coils."

Mr. Mordey defines an inductor in his patent as "the arrangement of a field magnet of laminated iron having a number of armature coils on its poles or projections, in conjunction with laminated iron masses caused to rotate in close proximity to the field magnet poles for the purpose of varying the magnetic induction."

The Ganz machine appears to have simply a rotating field magnet with an absolutely distinct armature of such construction that it precludes the exciting coil entering it. The fact that the single exciting coil does not revolve with the poles does not make the machine an inductor; if it did so revolve, nobody would think of calling it one.

Percy Rosling.

January 29th, 1900.

[The application of the term "inductor" to machines such as those at Leicester is a matter of universal practice. In our description of Mr. Mordey's new inductor alternator, Vol. 39, p. 416, 1896, we gave the following definition:—"An inductor machine . . . . belongs to the class of alternators distinguished by having the conductors fixed, both of the armature and of the exciting circuit, the E.M.F. being produced by a variation of the magnetic flux, brought about by a movement of a portion of the iron of the magnet circuit." Mr. Mordey, by the way, who himself calls the above machine an inductor alternator, is one of our correspondent's authorities.

Prof. Thompson is in agreement with Mr. Mordey, for in his well-known "Polyphase Electric Currents," second edition, p. 79, he says:—"Some, of the type known as 'inductor' alternators, have no revolving copper, the revolving 'inductor' being of iron or steel only"; and on p. 111:—"An 'inductor' machine, meaning one having no copper on the revolving part."

The last statement concisely sums up the matter, and is identical with our own view. The fact that the single exciting coil does not revolve with the rotor makes the machine an inductor alternator.—EDS. ELEC. REV.]

The Use of Rubber-Insulated Wire in Steel Conduits.

I am very sorry for Mr. W. H. Isherwood, but I did not, in my 1897 papers, allow that 300-megohm wire was "best work," nor do I now assume that it is the standard grade in insulating conduit work. I only regret to hear that Mr. Isherwood and others use it; but the makers of the conduit originally claimed that this grade was quite high enough, a point which I wished to disprove at the time.

The last paragraph in Mr. Isherwood's letter is a mere quibble, and does not call for any reply.

V. Zingler.

Information Wanted.

I should be much obliged if any of your readers could inform me on the following points:—

(1) What constitutes a "non-inductive coil?"

(2) What other methods are there of making a non-inductive coil besides winding the flow and return wires side by side in the form of a double-threaded screw?

(3) What are the advantages of carbon over copper or gauze brushes?

(4) Are carbon brushes suitable for switches for carrying all the current passing through them?

(5) What is a suitable current density for carbon motor brushes in which the motor is not run for more than one minute at a time, and is then idle for an equal time?

(6) What is a suitable current density for cable under the above conditions?

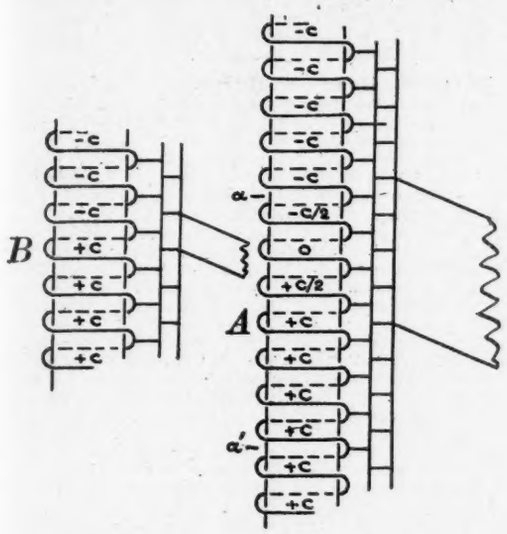
Student.

January 29th, 1900.

The Commutation of Dynamos.

Mr. David Rew, in a letter printed in your last number, argues that a diagram in Section 9 of a paper on the commutation of dynamos in your issue of January 12th shows that a thick brush may effect commutation in a weaker field than a thin brush, and differs from the conclusion that I drew. My argument was not sufficiently stated.

The annexed diagram shows the currents in the convolutions of an armature in the two cases of a thin brush, the width of a commutator segment, and of a thick brush covering four commutator segments. Consider the coil A about to undergo commutation. The flux through it due to the armature currents depends only on the coils between the points a, a', since the action of the coils beyond a in one direction balances the action of the coils beyond a' in the other direction; and the sum of the current turns in the coils between a and a', producing flux through A, is 4 C.



In the case of the narrow brush, the current turns on either side of B, balance one another, and the effective current turn, producing flux in B, is C. This consideration was taken to indicate that the flux in a coil which has to be reversed during commutation is proportional to the length of the commutation arc, and to the width of the brush, so that the reversing field has to be of the same strength in all cases.

A statement that the flux produced in A by the armature current is proportional to the sum of the current turns between a and a', while approximately correct, is not exact, and an argument based on it cannot be pressed. The word "indicates," used instead of "shows," or "proves," was intended to convey this. Mr. Rew's observation that a wide brush is frequently useful in reducing sparking, especially with slotted armatures, shows that the argument is worth less than I was inclined to suppose, and I am much obliged to him for calling attention to it.

W. A. P.

A Problem in Dynamo Design.

Referring to the figures you give in a "Problem of Dynamo Design" in your last current issue, I think some errors must have crept into the calculation. To start with, 12 ohms is rather a large value for the resistance of a mil-foot of copper, as at ordinary temperatures it is usually taken to be 10·3365 ohms. p and d also I make slightly different to your figures, 26 inches and 72 mils, and even after converting (drain, overall)^2 into (diameter)^2, I fail to get the figures (·087)^2.

Inquirer.

January 30th, 1900.

[In spite of our captious critic, there are no errors in the calculations—except the comical misprint of "drain" for "diam."

The resistance of a mil-foot of copper wire is "12 ohms at 60° C.," as we distinctly stated; our correspondent ought to be aware that magnet coils get hot.

The least rectangular perimeter of winding is $(7\frac{1}{2} + 4)\ 2 = 23$ inches; the greatest is $(9\frac{1}{2} + 6)\ 2 = 31$ inches; average 27 inches. Allowing for the necessary rounding of the corners, the nearest integral value of p is 26 inches.

The value of d, as calculated with a 10-inch slide rule, is a trifle over 72 mils—but wires are not drawn correct to a fraction of a mil.

The diameter overall is 72 mils + 15 mils d.c.c., or 87 mils, or 0·087 inch.

We have yet to meet with a specimen of copper wire whose resistance can be predicted to *one part in a million*, as our querist seems to think possible; seeing that copper resistance varies nearly 1 per cent. for 4° F. change in temperature, the very precise value given by "Inquirer" at "ordinary temperatures" is interesting. For practical purposes, calculations within 1 per cent. are nearly always sufficiently accurate.—Eds. Elec. Rev.]

REVIEWS.

Electro-Magnetic Theory. By Oliver Heaviside. Vol. II. The *Electrician* Printing and Publishing Company, Limited, London.

The whole of this volume has already appeared in the pages of the *Electrician*, and the character of Mr. Heaviside's work is too well known to require description here. The opening chapter of the book deals with the question of the age of the earth calculated from some hypotheses of cooling by Lord Kelvin and Prof. Perry, and seems to have no bearing on electrical problems, except so far as it illustrates the mathematical methods. The bulk of the work is concerned with electrical transmission and diffusion through various media, dealt with by means of applying mathematical operators to physical quantities very often vectors. There are a number of appendices or notes bearing on different special problems, of which one on the rational units would interest all electricians. Mr. Heaviside is an extraordinarily interesting and fresh-minded writer, and his mode of treating electrical problems has clearly a considerable influence on the thought of the present day. He appears quite insensible of the meaning of literary style.

Papers on Alternating Currents of Electricity for the Use of Students and Engineers. By T. H. Blakesley, M.A. Fourth English edition. London: Whittaker & Co.

That a fourth edition of this little book should be called for in England, as well as the fact that it has been translated into three foreign languages, is evidence of its value and interest. The new edition appears to be only a reprint of the former, except for a new preface. The new preface gives an interesting reference to the state of ordinary knowledge on alternating currents in 1885, when the book first appeared, and geometry began to be used in alternating currents, mainly, we believe, through Mr. Blakesley's work.

The whole subject of harmonic disturbances in electrical conductors is very attractive, both for the practical and the scientific electrician. In the first place the analysis is at once easier and more elegant than in probably any other physical problem, except the very simplest, and depends entirely on the two most familiar functions, the circular and exponential. Secondly, the transmission of electrical disturbance has a peculiar character, in that all the effects of a harmonic disturbance are harmonic of the same period. That this is not generally the case in physics is seen from the familiar behaviour of musical instruments and the phenomena of fluorescence. In consequence of this, where the original disturbance is represented by the projection of a rotating vector, all the effects can be represented in the same way by vectors rotating at the same speed, and the problems are susceptible of the curiously simple graphic treatment first systematically used by Mr. Blakesley. The prettiest example of this is the representation of the oscillatory discharge of a condenser by an isosceles triangle revolving and shrinking simultaneously,

but the assumption, or proof (we are not sure which is intended), that the work done in radiation is in phase with the current, does not seem satisfactory. In the third place the problems themselves are of immediate practical importance, and the modes of solution are practically useful.

The success of this book has been due, we think, to the point kept steadily in view throughout of its value to practical men, and the chapters on the use of the dynamometer are perhaps the most valuable, as well as being the most original. Like all other books we have seen where vectors are used, this leaves the readers with an impression of the great value of quaternions for statement and illustration, and of their small value for calculation. Their use in alternate current problems by Mr. Blakesley has greatly advanced the knowledge of the exact meaning of such quantities as "phase" and "lag" among practical engineers.

BUSINESS NOTICES, &c.

The Tyneside Electrical Power Scheme.—We have before us two circulars which have been distributed by the promoters of this scheme; one is to local authorities affected by it, and the other to manufacturers and other probable power users. The authorities are given a general outline of the project and details of the constitution of the company. The powers include the generation and supply of electrical energy throughout the whole Tyneside manufacturing district. The Tyneside Electric Power Company will have a capital of £500,000, and will be formed by the following local gentlemen, who are intimately associated with the leading industries of the district, and well acquainted with local requirements:—

Norman C. Cookson, Esq., chairman of the Tyne General Ferry Company, and of the Wallsend and Hebburn Coal Company; H. C. Harvey, Esq., of Messrs. Leadbitter & Harvey, Newcastle-on-Tyne; C. J. Leyland, Esq., director of the Parsons Marine Steam Turbine Company, Limited, Wallsend; J. D. Milburn, Esq., of Messrs. Wm. Milburn & Co., shipowners, Newcastle-on-Tyne; director of the Ashington Coal Company, Limited; Saxton W. A. Noble, Esq., director, Sir W. G. Armstrong, Whitworth & Co., Limited, Elswick; Hon. C. A. Parsons, F.R.S., Heaton Works, managing director of the Newcastle and District Electric Lighting Company, and of the Parsons Marine Steam Turbine Company, Limited; J. B. Simpson, Esq., managing director, Stella Coal Company, director of R. & W. Hawthorn, Leslie & Co., Limited; Eustace Smith, Esq., of T. W. Smith & Co., Sandhill, managing director, Smith's Docks Company, Limited; A. A. Campbell Swinton, Esq., M.I.C.E., electrical engineer, Westminster.

The advantages which must inevitably follow the cheap supply of electromotive power in such a district as the Tyneside are laid before the local authorities, the leading Tyneside industries being of such a character as should be peculiarly benefited thereby. Several of the most important works in the district are desirous of obtaining such a supply. A cheap electrical supply is also considered likely to lead to important developments in the local chemical industry. To afford the desired facilities and to secure the requisite economy, it is necessary to operate over a much wider area and on a much larger scale than would be practicable for any single local authority. The objects of the company are therefore to co-operate with the local authorities, and with their assistance, to establish throughout the whole manufacturing district on both sides of the Tyne, from Blaydon and Newburn on the West, to Tynemouth and South Shields on the East, a system by means of which electric energy can be supplied to factories, shipyards, and works of all descriptions, and also for both public and private lighting, either by the local authorities themselves or by the company direct. Negotiations are already in progress for acquiring suitable sites on the river, in a convenient situation, where there will be ready access for coal and water, and the company propose to erect generating plant by which electric power will be produced on a very large scale with plants each of several thousand H.P. The power will be distributed at high pressure to all required points in the district, where, by means of suitable transformers, the pressure will be reduced to such voltages as the consumers desire. An interesting feature of the scheme is the proposal to supply electric motors on hire, which will prove a convenience to those who require for any purpose small amounts of motive power. They will also be prepared, where desired, to arrange for the "free wiring" of shops, private houses, and business premises for electric lighting. No monopoly or exclusive right to supply electric energy in any district is sought.

It is not proposed to undertake the general distribution of electricity within the area of any local authority, except with the specific consent in writing of such local authority, or to confer by the Bill any powers over streets without a similar consent, except so far as may be necessary for the purpose of laying across the district of any one local authority such trunk mains as may be necessary in order to obtain convenient access to the district of any other local authority, who may either desire a supply of electricity in bulk, which they themselves will distribute, or who may have consented to the company affording a supply within their district as aforesaid.

The company will be bound to supply electricity in bulk at the rates given below to any local authority, any part of whose district is situated within the area of the company's operations, on such authority requiring them to do so, in accordance with the terms of the Bill, but there will be nothing to compel the local authority to take such supply from the company, or to prevent the local authority from generating its own supply.

Local authorities taking a supply of electricity from the company in bulk, will be entirely free to distribute it themselves, or if any local authority within the company's area prefers it, the company will do the distribution in addition to supplying the electric energy.

The company will charge for energy supplied in bulk at the following maximum rates, which will be automatically reduced when the company earns more than a certain percentage of profit:—

For the first 200 hours of supply at the maximum power demanded per quarter	4d. per unit.
For further hours of supply beyond 200 hours, and not exceeding 400 hours per quarter	2d. per unit.
For any further hours per quarter	1d. per unit.

The circular to manufacturers covers to some extent the same ground, but in addition it dwells particularly upon the advantages to be obtained from the substitution of electric driving for other methods of working.

Name Plates.—From Messrs. Luppe & Heilbronner, of Munich, we have received a specimen of their chemically engraved sign plates (relief and deep engraving) which they are supplying finished in any size, colour, form and thickness, either for large machines or small apparatus.

New Journal.—*The Electro-Chemical Review* is the title of a new montly journal (6d.) of which the first number, January 15th, is before us. The object of the paper, as announced in the editor's programme, is to assist "in the development of the electro-chemical industries which have made so much progress and have acquired so much importance during the last few years." The number before us has articles on electrolysis, electro-metallurgy, calcium carbide and acetylene, and one on the electric driving of bleaching, dyeing, finishing and printing machines, with a large illustration of a motor-driven calico-printing installation carried out by Messrs. Mather & Platt, Limited. The journal is conducted by Mr. Antonio Sansone, and it is published by Heywoods, of Manchester.

The Longest Rope.—We have received copies of correspondence which has been recently published in a contemporary regarding the longest rope in the world. Pressure upon our space prevents our re-publishing the letters in our columns, but briefly stated the matter is as follows:—Messrs. D. H. & G. Haggie, of Sunderland, claimed that the steel rope supplied by them for the Glasgow District Subway was the longest in the world, weighing about 55 tons, and they claimed that the excellent results of its working were largely due to improved machinery specially erected for the purpose of manufacturing cables. Messrs. W. F. Dennis and Co., British agents for Messrs. Felten & Guilleaume, followed this up by a statement that for years past they had manufactured steel wire towing ropes of 5½ inches circ. in one continuous length of 100,000 feet or nearly 19 miles, and weighing 210 tons. Messrs. Haggie then produced a letter from the makers who supplied to Messrs. Felten & Guilleaume a machine for manufacturing such rope. This was in 1872, and the greatest weight it would carry was one section of 16 tons. The machine maker added that therefore Messrs. Felten & Guilleaume's rope must be made in a number of lengths spliced together and not in one continuous length. This led to a further response from Messrs. Felten & Guilleaume, who showed that they had so developed their business since 1872 that their wire rope plant had had to be considerably increased, and the construction of machinery greatly improved, and they repeat that the cable was actually made and laid by them in one continuous length without any splice whatever, at the same time adding that they have themselves constructed all the new wire rope machinery they have required, and, in fact, can make ropes considerably longer than 20 miles in one length without splicing. They have even supplied machines to other wire rope manufacturers on several occasions. Having thus abstracted the correspondence, we leave our readers to judge who may rightly claim to be the manufacturers of the longest cable in the world.

Electricity in 1899.—In its retrospect of the year 1899 the *Scientific American* contains the following references to electricity:—"The year's progress in the electrical world has been marked by steady advance along established lines, with few or no startling inventions or discoveries to be recorded. Perhaps the most striking development has been that of wireless telegraphy, a system which was shown for the first time in successful commercial operation in this country by Marconi himself during the international yacht races. During the summer wireless messages were successfully transmitted between ships of the British Navy which were separated by 80 miles of water, and decipherable messages were also dispatched from Chelmsford, in England, to Boulogne, in France, over 110 miles of land and water. Marconi has done enough to establish the practical value of his system for certain specified work; but its value will be enormously increased if he can discover some means to restrict the receipt of messages to the particular station for which they are intended, and prevent all interference by the waves sent out from other stations that may happen to be within range. Scarcely less remarkable results in their way have been attained by the Pollak-Virag system of high-speed telegraphy; from 70,000 to 100,000 words per hour having been transmitted between Buda-Pesth and Vienna, while recently as high as 122,000 per minute were transmitted between Chicago and Buffalo. In this system transmission is effected by a perforated strip of paper, as in the case of the Wheatstone automatic, while a telephone fitted with two small mirrors serves as the receiver, the diaphragm of the telephone being set into oscillations corresponding to the current impulses generated by the transmitter. The *Scientific American* has devoted considerable space during the year to descriptions of the electrical development of the Niagara water-power. The close of the year sees the first half of the proposed 100,000 H.P. plant of the Niagara Falls Power Plant nearing completion, and steps being taken to duplicate the existing power house with another of equal capacity on the opposite banks of the company's feeder canal. The Hydraulic Power Company has an output of about 14,000 H.P., and improvements are under way which will increase this to 20,000. The Canadian Niagara Power Company is to commence work shortly on the development of 10,000 H.P., and altogether it may be said that the much talked of "harnessing of the Falls" as far as it has

gone has proved a technical and industrial success. Electricity continues to oust every other form of power for the operation of street railways, and the indications are that for city work the underground trolley will be the exclusive system, with the overhead trolley for suburban and short interurban lines. At the same time the third rail has given such good results on the New Haven Railroad that it is not improbable that the Shore Line from New Rochelle to Harlem will be equipped with a third rail. The electric equipment of steam railroads, however, is not proceeding as quickly as many people had expected, although the great system of the Manhattan Elevated is to be electrically equipped, an order for several thousand tons of third rail having been placed during the year. Another change from steam to electricity that has been determined upon, is the equipment of the Metropolitan Underground Railway in London. In this connection mention must be made of the excellent economy shown last year by the electric lines of the Metropolitan Street Railway Company in this city, which cost for operation per car mile 11·95 cents as against 17·96 cents for the horse car roads, and 17·99 cents for the cable roads. A service of compressed air cars has been started on two crosstown lines of this company, but it is too early to make any comparison of results with the electric or cable roads. The steam locomotive still holds the field as *par excellence* the traction motor for heavy or long distance trains, the Heilmann electric machine notwithstanding, and there is no evidence that it is likely to be displaced. The automobile field is no longer all but exclusively occupied by the gas engine and the electric motor; for the improvements in steam motors have been so great as to promise that this long-established, well understood and easily managed form of power may yet become the most popular for the automobile, with compressed air a possible rival. In its "Chemistry" remarks our contemporary says:—"Electric lighting has recorded no developments worthy of special mention, for great as were the expectations based upon the new Nernst lamp, they have not been fulfilled. Acetylene, on the other hand, has fully justified expectations, and both as an illuminant and a source of motive power it is giving excellent results."

Bankruptcy Proceedings.—Notice is given of release of trustee (Mr. Howard W. Cox) in *re* D. W. Paine, electrician, Gloster Road, Brighton.

Notice is registered in the *London Gazette* of intended dividend in the case of E. B. Pym, electrical engineer, late of Scarborough, and now of South Kensington. February 10th is the last day for receiving proofs. Mr. A. H. Wildy is trustee.

The first meeting and public examination in the case of Frederick King, electrical engineer, Bristol, are to be held on February 7th and 9th respectively at Bristol.

Notice of intended dividend is given in *re* Wild, Rothwell & Co., general and electrical engineers, Southport.

Notice is given of release of trustee (Mr. T. H. Winder, official receiver) in *re* Pimbley Bros., engineers and fuel economiser makers, Albert Works, Moses Gate, near Bolton; also a similar notice is made *re* Mr. A. Mackintosh, trustee in *re* Frederick Jones, electrical engineer, Wandsworth.

Dissolutions and Liquidations.—A meeting of the Electric Lighting Extension Syndicate is to be held on March 1st, at Bartholomew Works, Lawford Road, Kentish Town, N.W., to hear an account of the winding-up from the liquidator, Mr. C. O. Bastian.

A meeting of the New Electricity Supply Syndicate will be held at 24, Harleyford Road, Vauxhall, S.E., on Friday, March 2nd, to hear an account of the winding up from the liquidator, Mr. Frederick King.

Notice appears in the *London Gazette* of the dissolution of partnership in August, 1899, between Messrs. R. P. Wilson and W. H. Story (Wilson & Story, consulting engineers, of Victoria Street, S.W.). Mr. Wilson attends to debts.

Meeting of Creditors.—Last week a meeting of creditors of Mitchell & Schofield, electrical engineers, Brockholes, was held at the office of Messrs. Armitage, Sykes, & Hinchcliffe, solicitors, Huddersfield. The statement of affairs showed liabilities £696, and assets £455. It was decided that the debtors should execute a deed of assignment to Mr. Tate as trustee, and a committee of inspection was appointed.

Books Received.—"Street's Newspaper Directory, 1900." London: British, Foreign and Colonial Advertising Offices. 3s. 6d.

"Transmission de L'Electricité Sans Fil," par Emile Guarini-Foresio. Liége: Imprimerie Liégeoise, Henri Poncelet. 2 francs.

"Fire Tests with Doors." Nos. 35 and 39. London: The British Fire Prevention Committee. 2s. 6d. each.

Catalogues, &c.—Messrs. Tangyes, Limited, have issued a list giving reduced prices of "unrevised machinery" at present in stock, including steam boilers, pulley blocks, cranes, machine tools, pumps, &c., also second-hand Tangyes' steam and gas engines, and ram pump and boiler feeder.

Messrs. Nalder Bros. & Thompson, Limited, send us, as usual, one of their convenient wall calendars for 1900.

A very neat calendar card comes to hand from Messrs. McClure and Whitfield, of Stockport. The chief feature is a reproduction from a photo of the interior of the Stockport electricity works, where there are two 240-H.P. and three 90-H.P. "Mersey" generators.

From the Westinghouse Companies' Publishing Department we have received a copy of each of the following circulars which they have just published:—No. 1,011, Direct-connected Railway Generators; No. 1,012, The Shallenberger Ampere-hour Meter; No. 1,013 relating to switches (Plunger type) for 1,100 and 2,200 volt alternating current circuits, and No. 1,014 describing ammeters and voltmeters (round pattern); all the circulars are, as usual, very neatly illustrated.

Messrs. Wm. M'Geoch & Co., of Birmingham, have issued a small pamphlet to users of electric motors in which they describe Wilson's patent automatic safety starting switches for electric motors. This apparatus they claim to be essentially British, both in design and manufacture. The list is illustrated with general views and diagrams of connections, and gives prices. A form for filling in certain instructions when ordering, is provided.

The Edison & Swan United Company send us the following leaflets: No. 139, showing their revolving stand outfit for shop window exhibition purposes, and their ornamental cover tumler switch; No. 140, dealing with the "Rapid" detector for testing electric lighting, telephone, and bell installations, and the "Balgrave" telephone for private houses, hotels, &c.

The Klein Engineering Company, Limited, sends us a fully and well-illustrated list of its independent steam or electric-driven central and accumulator condensing plants, jet, surface, and ejector condensers with or without Klein's coolers. A list is given of the electricity works and railways in which Klein condensing plants are employed.

The B.T.H. Co. has issued a pamphlet giving photographic views and general particulars of direct-connected traction and power generators. The views include the Bristol, Cork, Colombo, Dublin, and North Staffordshire tramway stations.

Mr. Claude W. Hill, London agent for Messrs. J. P. Hall & Co., of Oldham, sends us a few sheets of illustrations of that firm's most recent machines, including combined multipolar machines compound-wound three-bearing dynamo and four-pole open-type ditto, all with slotted drum bar armatures; and four-pole enclosed motors. They make a special machine for electric traction and power work.

Messrs. Polland & Co., of Newcastle, have issued a new price list of "Vulcan" arc light carbons and dynamo brushes.

The American Blower Company, of Gracechurch Street, E.C., who state that during last year their works at Bedford and in America were extended, have addressed to us copies of two of their sectional catalogues. The A.B.C. fan system of heating and ventilation as applied to factories, mills, machine shops, &c., is described with illustrations. The company also issues various other sectional catalogues in various languages referring to its drying systems, water heaters and purifiers, high-speed engines, fans for mechanical draught, &c.,

Messrs. Marryatt & Place, of Hatton Garden, E.C., are sending out circulars relating to their "M.P." switches for electric light and power. Among the illustrations is one of a switchboard supplied by them for a 300 H.P. electric motor-driven printing installation.

Correction.—In our recent account of the Bolton electricity works, the boiler fittings and valves were inadvertently wrongly described; the whole of these were made by Messrs. J. Hopkinson and Co., Limited, of Huddersfield.

Directories.—The 1900 edition of *Street's Newspaper Directory* has just been issued. The arrangement of the names of the various papers published throughout the United Kingdom is as usual very convenient, and those who have occasion from time to time to transact business or correspond with them will find the directory of great assistance. This directory is essentially the business man's book. (London: 5, Serle Street, W.C. 3s. 6d.)

We have also received the 1900 edition of the *Export Merchant Shippers' Directory*. The compiler has made no fresh departure in the present volume, contenting himself with extending and bringing the list of the shippers in the "Export Section" thoroughly up-to-date, which at the same time increases the utility of the "Itinerary," as all shippers in the E.C. district appearing in the one are also included in the other; the "Index to Exporters" has been also enlarged, the "Trade Mark Section" and the "Manufacturing Section" having been increased judiciously in proportion. 2,700 new names have been added to the work, and the same compact form and general classification and arrangement as heretofore have been adhered to.

Electric Light Fittings.—We suppose if anybody needs a "taking" catalogue it is the electrical fittings manufacturer, for the customer who is having his premises fitted up for electric lighting wants to examine the various designs alone so that he may select something which will suit his own particular tastes, and be most likely to fit in with the general characteristics of his own establishment. Manufacturers of electroliers, pendants, &c., have shown great enterprise in the production of books of designs, as we have frequently stated, and they have taken advantage of the fact that the class of goods they produce lend themselves very readily to the exercise of artistic talent. These remarks apply with special emphasis to a bound collection of designs, now on our desk, showing a charming variety of electroliers, brackets, table standards, and other fittings specially suitable for private house lighting, &c., manufactured by Messrs. F. & C. Osler, at their works at Birmingham, and stocked by them at their London showrooms in Oxford Street. The illustrations have received great attention, with a very satisfactory result. They are printed from blocks make by photo-zinco process from wash drawings. A stiff paper is used, and the necessary letterpress is given on a thinner sheet, which is attached in a very neat manner.

Trade Announcements.—Messrs. Meldrum Bros., of Manchester, have, for the greater convenience of their rapidly increasing connection, opened offices at 2, Prince's Mansions, 66, Victoria Street, Westminster, S.W.

The British Thomson-Houston Company, Limited, have occupied new additional premises at 6, Bath Street, City Road, E.C.

Electrical Wares Exported.

Week ending Jan. 24th, 1899.		Week ending Jan 23rd, 1900.	
Alexandria. Elec. fuses	Value £55	Auckland	Value £121
Amsterdam	125	Bangkok	127
Auckland	223	Bombay	7
Calcutta	1,698	Calcutta	267
Cape Town	845	,, Teleg. wire	93
Christiania	100	Callao. Teleg. wire	64
Colombo	69	Cape Town. Teleg. mat. ..	1,008
Copenhagen	14	Channel Islands	1,140
Delagoa Bay	10	Chinde. Teleg. mat.	3,322
Durban	98	Christiania. Teleg. wire. ..	29
East London	1,268	,, Teleph. cable ..	950
Flushing	11	Copenhagen. Teleg. cable ..	167
Gothenburg	100	Durban	63
Hamburg. Teleg. mat.	110	,, Teleg. mat.	232
Lyttelton (N.Z.)	32	East London	71
Melbourne	145	Flushing. Teleg. mat.	96
Montreal	11	Gibraltar	192
Ostend	5	Halifax	80
Port Elizabeth	1,416	Hong Kong	624
Reval	66	Malaga	100
Shanghai	81	Marseilles. Teleg cable ..	1,294
Sydney	81	Mauritius	352
Wellington (N.Z.)	740	Montreal	54
		Ostend	87
		Port Chalmers	35
		,, Elizabeth	172
		,, ,, Teleg. mat. ..	231
		Shanghai	207
		Singapore	52
		Stockholm. Teleg. mat. ..	171
		Sydney	1,294
		Valparaiso	36
		Wellington	145
		Yokohama	568
Total ..	£7,303	Total ..	£13,456

Electrical Wares Exported.

Week ending Jan. 31st, 1899.		Week ending Jan. 30th, 1900.	
Adelaide. Teleph. appe.	Value £1,270	Alexandria	Value £194
Amsterdam	75	Amsterdam	295
Antwerp. Electric fuses ..	225	Barcelona	31
Bilbao. Teleg. cable	282	Bombay	96
Boca. Teleg. mat.	247	Boulogne	133
Bombay	265	Bremen. Teleg. instruments ..	360
Calcutta	87	Buenos Ayres	270
Cape Town	257	,, Teleg. mat. ..	1,650
Colombo	16	,, Teleph. cable ..	185
Delagoa Bay	144	Calcutta	2,964
Durban	595	Cape Town	347
East London	190	Chinde. Teleg. mat.	864
Ghent	82	Christiania. Teleg. cable ..	150
Hamburg	180	Colombo	77
Hiogo	134	,, Teleg. instruments	84
Hong Kong	561	Copenhagen	126
Marseilles. Teleg. mat. ..	765	Durban	789
Mauritius. Telep. stores ..	94	,, Teleg. mat.	681
Melbourne	212	East London	33
Montreal	42	Flushing	81
Port Said	135	Gibraltar	25
,, Teleg. mat.	69	Halifax	17
Reval. Teleg. mat.	334	Hamburg	25
Rotterdam. Teleg. mat. ..	55	,, Teleg. mat. ..	300
,, ...	50	Hong Kong	316
Sydney	718	Karachi	96
Trieste. Teleg. mat.	500	Launceston	210
Yokohama	389	Madras	67
,, Elec. instruments	1,010	Malta	19
		Mauritius	116
		Melbourne	316
		St. Petersburg. Teleg. mat. ..	1,000
		Santos	41
		Shanghai	254
		Sydney	153
		,, Teleg. mat.	282
		Tientsin	20
		Toronto	85
		Trieste	70
		Yokohama. Electric cable ..	67
Total ..	£8,983	Total ..	£12,609

Foreign Goods Transhipped.

Sydney. Teleph. wire £123

Annual Dinner.—The second annual dinner and dance of the electrical department employés and friends of Messrs. D. Bruce Peebles & Co., of Edinburgh, was held on Friday last, Mr. R. S. Portheim presiding. There were over 300 present, and a most enjoyable evening was spent. The arrangements were in the hands of Mr. Hart (foreman winder) and Mr. Whitelaw (general foreman).

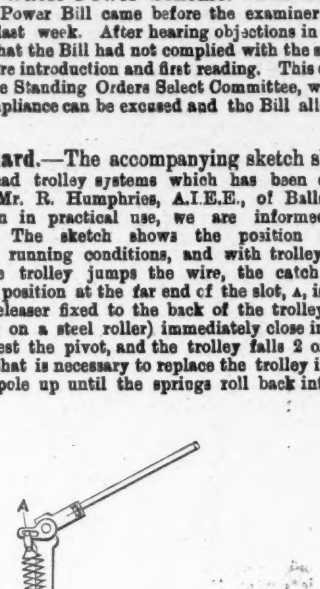
Klein's Condensing Plants.—Mr. Jarvis, the North-East Coast licensee for the above plants, has been instructed to supply a Klein's patent water cooler for the condensing plant at the Middlesbrough electricity station, for which Mr. Hammond is consulting engineer. Amongst other corporations who have adopted Klein's system of water cooling and condensing at their electricity stations are, Liverpool, Bolton, Oldham, Tynemouth, Birmingham, St. Helens and Warrington. This system of cooling is being rapidly adopted here, the plants already erected, or in course of erection, being equal in cooling capacity to a reservoir covering 300 acres, 1 foot deep, capable of holding 80,000,000 gallons of water. Sufficient land can rarely be spared for the purpose of cooling the water required for condensing, and many steam users have been compelled to forego the advantages and economy which might otherwise be obtained, but it is claimed that with Klein's system so little space is taken up that everyone may obtain by condensing a great economy in fuel and water, which is a matter for serious consideration at all times, but especially so now when the price of fuel is so high.

Railway Train Lighting.—Messrs. Ellis & Ward, of Birmingham, have recently completed the electric lighting of a large number of railway carriages for the Natal and Cape Governments. We are informed that the work has been carried out under great pressure, owing to the requirements of the present war.

Russia.—The Russian Electrical Company (Siemens and Halske), of St. Petersburg, is declaring a dividend of 5½ per cent. for the financial year 1898 99, as compared with 6½ per cent. in the preceding year.

The Shannon Water-Power Scheme.—The Shannon Water and Electric Power Bill came before the examiner, at the House of Commons last week. After hearing objections in opposition, it was declared that the Bill had not complied with the standing orders applicable before introduction and first reading. This decision will be referred to the Standing Orders Select Committee, who will decide if the non-compliance can be excused and the Bill allowed to proceed further.

Trolley Safeguard.—The accompanying sketch shows a safeguard for overhead trolley systems which has been devised and protected by Mr. R. Humphries, A.I.E.E., of Ballsbridge, Dublin. It has been in practical use, we are informed, with satisfactory results. The sketch shows the position of the trolley pole under running conditions, and with trolley wheel on wire. When the trolley jumps the wire, the catch which holds the springs in position at the far end of the slot, A, is lifted automatically by a releaser fixed to the back of the trolley stand. The springs (running on a steel roller) immediately close in to the end of the slot nearest the pivot, and the trolley falls 2 or 3 feet below the wire. All that is necessary to replace the trolley in position is to push the pole up until the springs roll back into their



original position, where they are caught and held automatically by the catch. The releaser (which is hinged) is then pushed up, and the car again started. The whole operation, it is said, can be performed easily in two minutes. With this device the trolley rope can be tied up to the pole out of the way of passengers and accidental pulling and catching, and the conductor is free to perform his duties instead of constant rope clutching and trolley gazing. The overhead construction is claimed to be absolutely safeguarded, the device acting instantaneously.

Tudor Accumulators. — Referring to the notice we inserted in our issue of 19th, that Mr. Edward Lomer, of 12, St. Mary Axe, E.C., had been appointed agent of the Accumulatoren Fabrik in this country, Mr. Lomer now informs us that this announcement was due to a misunderstanding, and that the Tudor Accumulator Company, Limited, have the sole rights for the manufacture and sale in the United Kingdom of Tudor accumulators, which is the type of cell manufactured by the German company referred to above.

ELECTRIC LIGHTING NOTES.

Belfast.—At a meeting of the Electricity Committee last week, the engineer, Mr. V. A. H. M'Cowen, submitted his report, from which it appeared that the increase in units sold during the past year was 76 per cent. while the increase in revenue was only 1 per cent., thus indicating very considerable reduction in the price of current to consumers. The average price for current for lighting during the year was 4½d., and for power purposes 2¾d. per unit. The Committee has under consideration the reduction in price of current for motor purposes. The total number of lamps applied for and connected up amounts to over 58,000.

Berwick.—The Sanitary Committee has approved of the draft of the provisional order submitted to it by Messrs. Edmundson's Electricity Corporation, Limited, for the electric lighting of Berwick.

Birkenhead.—On Friday last week a Local Government Board inquiry was held into the application of the Corporation for power to borrow £3,500 for the purpose of extending the electric light to various roads in Higher Tranmere. There was no opposition.

Birmingham.—What is believed to be the largest electrically-driven cold storage plant in the country is at present being put down for the Birmingham Cold Storage, Limited, for the purpose of storing hops. The premises are those lately occupied by the

Crown Brewery, and are being converted for the purpose of cold storing hops. The plant consists of two Linde compressors, driven by two 30-H.P. Turner motors, three of the same make of 7½ H.P. each being employed for running the auxiliary apparatus. The contractor for the building is Mr. Rowbotham, of Birmingham; electric lighting, Messrs. P. C. Middleton & Co., Limited, Aberdeen; refrigerating plant, the Linde Company; insulating of cold rooms, the Insulating Syndicate, Limited; and motors, Messrs. John Turner & Sons, of Denton. The consulting engineers and architects for the company are Messrs Harrap, Hewett & Duffield, of 5, Budge Row, E.C.

Bedford.—The Town Council has accepted the tenders of Messrs. W. H. Allen & Son for a steam engine, at a cost of £1,600, and Messrs. Rosling & Appleby for an alternator, at a cost of £1,200.

Bridgwater.—Although the Corporation possesses a provisional order for electric lighting, it was decided at a ratepayers' meeting last week that the scheme should be shelved.

Chorley.—At a meeting of the Town Council of Chorley, Lancashire, on January 25th, it was resolved that the town clerk make application to the Local Government Board for leave to borrow £23,000 for the purpose of carrying out the electric lighting scheme in the borough, in accordance with the provisional order obtained some time ago. The scheme in question is one based on a report of the firm of Messrs. Lacey, Clirehugh & Sillar.

Dublin.—The Corporation has lodged a memorial in regard to the County and City of Dublin Electric Lighting Bill, alleging non-compliance with the standing orders.

Dundee.—The Tramways Committee of the Dundee Town Council met last week, when a report on the electric lighting extensions in the city was submitted. It is proposed that condensing plant should be obtained at a cost of £3,500, feed and exhaust piping at £2,000, feed pumps, &c., at £1,000, and conduits for cables in the Perth Road at £5,175, making in all an expenditure of about £12,000. The Committee approved of the proposals, and will recommend accordingly.

Gravesend.—A discussion took place at a meeting of the Town Council on January 24th, anent the receipt of a letter from the Drake & Gorham Electric Power and Traction Company, Limited, asking the Council to transfer the electric light order to them. The members did not receive the letter with favour, the general opinion being that the offer was not good enough. There also appeared to be a feeling in favour of the town carrying out the order, but eventually the matter was deferred to the next meeting.

Ingleton.—The formal switching on of the electric light in this Yorkshire mountain resort took place on January 24th. The Parish Council has entered into a three years' agreement with the Electric Lighting Company to supply current for street lighting for £70 per annum. The capital of the company is £4,000, and of this £3,500 has been subscribed, this paying the costs of the various contracts and some of the formation expenses. Water-power is obtained from the River Greta, the weir being 40 feet wide, and in the power house there are placed two Vortex turbines, each capable of developing from 15 to 20 H.P., and driving two dynamos with maximum outputs of 35 amperes, 330 volts. In the battery house in the centre of the town there are 116 accumulator cells, the total capacity of the battery being some 750 ampere-hours. The contractors were:—Hydraulic works, Messrs. G. Gilkes & Co, Kendal; electrical plant, Messrs. Drake & Gorham, Manchester; sub-contractors for street wiring and cables, Messrs. Callender's Cable and Construction Company, Limited, London. Mr. M. Harris (of Messrs. Gilkes and Co.) superintended the installation.

Italy.—A company has just been formed at Voghera to establish a plant for the utilisation of the power of the River Terdoppio. It is estimated that 800 H.P. will be available, and the electrical energy generated is to be used for the Casteggio-Pavia electric tramway and for lighting purposes in a number of small towns in the district.

Kendal.—It is recommended that the Council call a meeting of the General Purposes Committee to consider two reports from Messrs. Handcock & Dykes, dealing with electric lighting and tramways. For the lighting, the first report recommended a plant for 5,000 8-C.P. lamps, costing £15,000, but the Corporation decided to limit it at first to 2,500 8-C.P. lamps, and to lay mains throughout the compulsory area at about £10,000. Messrs. Handcock & Dykes drew out an estimate for the reduced capacity, this showing the cost £8,568, exclusive of buildings and fees. A committee has recommended the adoption of this scheme, but the questions of public lighting and of running a feeder main to the head of Finkle Street will remain in abeyance for the present, and until the Council have had the opportunity of considering the question of arranging for the supply of power to a company for a service of electric tramways in the borough, the preparation of specifications and the obtaining of firm tenders in connection with the proposed electric installation are to be deferred. In regard to the tramways question, the Electric Sub-Committee reported that Mr. Bolton had written to Messrs. Handcock & Dykes, asking how the question of electric trams would affect the capital outlay required. Messrs. Handcock & Dykes had reported that the additional cost for plant to supply electricity for a tram service of sufficient frequency to meet the requirements of Kendal, would cost a further £1,300, approximately. The tramways would require about 120 units per day, and the increase in the annual expenditure would come out very nearly at £165. Part of the additional plant would be available for electric lighting purposes as well as for the tramways. If the Corporation would give the matter their favourable support, they could find a company which would do all that was necessary in the way of putting down plant and working and maintaining the trams at their own expense, the understanding being that they should pay 1¾d. per Board of Trade unit for the motive power. That would bring the Corporation a revenue, with a fairly frequent service of trams, of about £262 per annum, as against an expenditure, as set forth, of £165; so that they suggested that the Council should decide whether it would be prepared to supply power at 1¾d. per Board of Trade unit, as the willingness of any company to take up the matter would, of course, depend entirely on that figure.

London.—The scheme for which a Bill is being promoted by the County of London and Brush Provincial Electric Lighting Company in the present session of Parliament, though not so extensive as that which was promoted in the last session, confers important powers upon the company. In addition to acquiring large areas of land in Camberwell, Wandsworth, Southwark, Streatham, and St. Luke's, for the purpose of erecting new generating stations, powers are sought to connect portions of the districts with generating stations in other districts by means of cables carried through the intervening districts, and to abstract water for condensing purposes from the River Wandle, the Surrey Canal, and the Regent's Canal. It is expected that considerable opposition to the Bill will be raised by the local authorities affected by the measure. A conference of such is to be held on the 13th inst. to discuss the proposals with a view to united action being taken. The question of subsequent purchase will be raised in connection with the company's proposal to make a single annual statement of accounts in respect of all its undertakings instead of a separate account for each concern.

The Parish of St. Martin-in-the-Fields has resolved upon an electric street lighting system. About 100 electric arc lamps are to be erected.

At a meeting of the Marylebone Vestry on Friday last, a deputation was received on the subject of electric lighting in the parish; it was stated that the supply had failed even during the past week, and the deputation urged the Vestry to take the matter into its own hands. After a long discussion the Vestry resolved to apply to the Board of Trade for a provisional order for electricity supply.

The County Council having received notice from the Charing Cross Electricity Supply Corporation of its intention to lay mains along the Victoria Embankment and certain streets, has sanctioned the performance of the work so far as its jurisdiction extends, subject to the usual conditions.

The Electric Lighting Committee of the Paddington Vestry reported that it had considered the petition with regard to the complaints against the Metropolitan Electric Supply Company, referred to it at the last meeting of the Vestry, and after consulting its solicitor, had come to the conclusion, that whilst it would bring pressure to bear on the company to fulfil their obligations, it was beyond its power to interfere in the cases of private consumers, who must take proceedings for themselves. The report was adopted.

North Wales.—The Committee of Visitors of the County Lunatic Asylum have decided to proceed with the electric lighting of the buildings.

Perth (W.A.).—The half-yearly report of the Perth Gas Company, Limited, shows a profit balance of £2,604 on a turnover of £8,357 in the electricity department; the capital expended is about £32,000. The gas undertaking, which shows practically the same turnover and net profit, has cost about £45,000, so that the electrica branch is seen to be a far better investment than the gas works.

Redruth.—The District Council has passed a resolution authorising the Urban Electric Supply Company, Limited, to apply to the Board of Trade for a provisional order for the supply of electricity in the district.

Rhondda.—The District Council will oppose the scheme of the South Wales Electrical Power Distribution Company if it finds that that company contemplates lighting the Rhondda district with electricity.

St. Helens.—A Local Government Board inquiry was held on Thursday last week into the application of the Corporation for leave to borrow £20,000 for electric lighting purposes. There are now 150 consumers, with 10,612 lamps connected. The electrical engineer, Mr. J. S. Highfield, gave details of the extensions which it is proposed to carry out, and the inquiry closed without opposition.

Salford.—A special meeting of the Salford Town Council was held on the 24th ult., when it was unanimously decided to promote a Bill during the ensuing Session of Parliament to enable the Corporation to enter into agreements with the councils of districts adjoining the borough for the supply of electrical energy by the Corporation within such districts, and further to supply and deal in electrical motors and apparatus.

Sculcoates.—The Local Government Board has sanctioned the raising of a loan of £1,400 by the Board of Guardians for electric lighting purposes, the money to be repaid in 10 years.

Sevenoaks.—The District Council, which had resolved to oppose the application of the Electrical Power Distribution Company for a provisional order, but had no intenion of undertaking the supply of electricity on its own account, has been induced to reconsider the matter. The company undertakes to sell its order to the Council, should the latter so desire, on or before September 30th, 1900, at cost price, provided that, if the Council does not forthwith proceed with the work, the order shall be returned to the company By this means the company will be able to avoid the loss of a year. Acting on Mr. Hawtayne's advice, the Council has provisionally agreed to this arrangement.

Shipley.—The District Council has resolved that Mr. R. Quin, of Blackpool, be appointed electrical engineer for carrying out the electricity supply scheme, and that he prepare plans and estimates for the purpose of making application to the Local Government Board for sanction to a loan for £22,000.

South Wales.—The Risca District Council has decided to oppose the Bill being promoted by the South Wales Electrical Power Distribution Company.

Smethwick.—An electric lighting plant of 120 H.P. is now being put down for Messrs. Mitchells & Buttes, Limited, of the Cape Hill Brewery, Smethwich, consisting of two dynamos driven by Crossley gas engines. The installation is on the three-wire system with accumulators, and the whole of the buildings are served by underground mains laid by Messrs. Callenders. The consulting engineers are Messrs. Harrap, Hewett & Duffield.

Swinton and Pendlebury.—The District Council has resolved to adopt electric lighting, and will shortly call in an engineer to draw up a scheme.

Train Lighting.—From a report recently made by Messrs. Preece and Cardew on the cost of lighting railway carriages by electricity, says the *Railway Times*, it appears that the total annual cost per coach would be £13 16s. 6d., based on the cost of fitting and running 400 coaches with an average of 12 lamps of 8-C.P. per coach. The total capital outlay for lighting this number of coaches is estimated at £32,000. These figures somewhat exceed those contained in a report on the same subject by Mr. Worby Beaumont some months ago.

Twickenham.—The District Council has refused to consent to the application of the Richmond Electric Light and Power Company, Limited, to the Board of Trade for a provisional order for the supply of electricity in the district.

Walker.—A Local Government Board inquiry was held last week respecting the application of the Walker Urban District Council for leave to borrow the sum of £28,356 for electricity supply and refuse destruction works. The application was opposed by the North-Eastern Railway Company, the Walker Coal Company, Messrs. Armstrong, Mitchell & Co., Mr. Wigham Richardson and others.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birkdale.—The District Council will oppose the Southport Extension and Tramway Bill, and it is intimating to the Birkdale and Southport Tramways Company its desire to purchase that part of its undertaking within the Birkdale district. The Council proposes to transfer its electric lighting powers to the British Electric Traction Company or other approved company. A site for electricity works is being purchased off Shaftesbury Road.

Bombay.—The question of the municipalisation of tramways is just now to the front, both in Madras and in Bombay. In the former city, however, tramways are already driven by electric traction, which is not the case in the younger presidency. But there, too, says *Indian Engineering*, the Bombay Tramway Company has applied to the Municipality to convert horse into electric traction. The proposal was placed before the Corporation at its meeting last month, when a strong committee was nominated to seriously examine it, and make a report thereon.

Bristol.—The work of converting the Bristol horse tramways to electric lines is still engaging a large number of workmen. Wood paving is largely used in the city, and in such cases the tramway operations are rather troublesome in their nature, owing to the solidity of the concrete which the Corporation provide as a foundation for the paving blocks. The work of cutting through this layer of concrete is almost as difficult as if a foot of rock had to be excavated, and this has to be done as a preliminary to laying new lines, to a smaller extent when bonding existing lines, and on a large scale in laying the cables. The company, of course, put down equally solid foundations in restoring the road, after their operations. Hard, red Australian wood is being used largely for their wood paving, its durability and cheapness making it far superior to the soft wood from Sweden. The metals are linked by substantial copper bonds—a pair being used at each joint. To carry the underground cables an extensive system of pipes beneath the roadways is being provided. Excavation for these is in places carried to a considerable depth, and the work has proved a heavy one. The trench is given a bottom of concrete; on this three or more pipes are laid, then there is another layer of concrete followed by a further row of pipes, and so on as required. Six or more pipes are common on main lines, but in certain parts a much larger number is used. The pipes are of riveted iron, cement lined, and the socketing is made secure by cementing. At short intervals in these underground conduits brick chambers are introduced; they are solidly constructed, and the road above them is carried on iron girders supporting concrete. Each chamber has a manhole. Span wires to support the trolley wire are almost general, and Bristol pavements being as a rule narrow, a certain amount of grumbling is heard at the obstruction of the poles erected at short intervals in the kerbs on both sides of the road. Arrangements between the Sanitary Committee and the tramway company have been going more smoothly of late, but a cause of difference has now arisen with respect to the widening of Lawrence Hill railway bridge on part of the system already electrically worked. The Sanitary Committee say the need of widening was hastened by the tramway traffic, and the improvement having cost the city £25,000, they met the request by the company to substitute double lines for the present single line over the widened bridge by the condition that the company should, as some contribution to the work, lay the widened bridge roadway with wood. The company declined to do more than the space between the lines and an 18-inch margin outside the metals. Laying wood on the rest of the road, as the Committee desire, would cost them £1,950 more. As a result the relations between the company and Committee may be again described as somewhat strained.

Clontarf and Hill of Howth.—Last week in the Dublin Court of Appeal, before the Lord Chancellor, Lord Justice Fitzgibbon, and Lord Justice Holmes, the hearing of the appeal of the Clontarf and Hill of Howth Tramway Company against the decree of the Master of the Rolls, in the action brought by Lord Ardilaun to restrain that company from carrying out certain works in connection with the construction of its Clontarf and Hill of Howth line, was resumed. Judgment was reserved.

Darlington.—It is stated that the differences between the Corporation and the Imperial Tramway Company are likely to be arranged, having been narrowed down to comparatively minor points. The Corporation, who are to supply the electric power from their new works, which are being constructed, are also arranging to light the main thoroughfares by the electric light.

Dublin.—A motion came before the Lord Chief Justice and Justices Boyd and Kenny in the Dublin Queen's Bench Court last week for a new trial of Harten *v.* Dublin Southern District Tramway Company, which came before Mr. Justice Johnson last term and ended with a verdict for the plaintiff for £666. The plaintiff was a publican resident in Upper George's Street, Kingstown, and the alleged cause of action was that the defendants on divers dates in 1895 and 1896 wrongfully altered the road and footpath running in front of the plaintiff's shop, and obstructed and interfered with the access to it. There were several defences pleaded—first, a traverse of the alleged acts, and next a justification under their order in Council, and, thirdly, they justified under the authority of the Kingstown Commissioners, who, they alleged, had statutory power and authority to alter the levels of the streets. The alterations of which the plaintiff complained had been made by the alteration of the level of street at the time of the relaying of the tram lines for the electric tramway. In his Lordship's opinion, the real cause of action was not the lowering of the street, but the lowering of the pathway and the making of a second step at the entrance of the plaintiff's shop. He was of opinion that the defendants were not responsible for the lowering of the footpaths, and as regards the lowering of the roadway they were justified in doing it under the authority of the town surveyor of the Kingstown Commissioners. The verdict should be entered for the defendants. Mr. Justice Boyd and Mr. Justice Kenny concurred. Judgment was entered for the defendants, with costs of the motion.

Halifax.—The Tramways Committee on 25th ult. had before them a letter from Elland District Council intimating that they intended to oppose in Parliament the Halifax Corporation Bill in regard to the proposed Elland tramway, but asking that they might have an interview with the Committee. It was resolved to reply that, as the District Council had decided to oppose the Bill, there was no need for any further communication between the two bodies. The suggested interview was accordingly declined.

Leith.—A deputation from the Leith Town Council, including the electrical engineer (Mr. Bryson) and the surveyor, conferred with the directors of the Edinburgh and District Tramways Company last week. The Council had previously passed a resolution to endeavour to arrange with the two tramway companies as to the purchase of the Leith tramways and their subsequent leasing to the Edinburgh and District Council. The Council's proposal as a basis of negotiation provided for extending the cable traction from Pilrig to the foot of Leith Walk, and converting the other lines within the burgh to electrical traction. In the course of the conference it was stated that the company would be very glad to co-operate with the Leith Corporation in the manner proposed, but asked for information as to the probable capital involved in the purchase of the Leith tramways, the cost of extending the cable line to the foot of Leith Walk, and also the cost of constructing and equipping the other tramway lines within the burgh for electrical traction. Mr. Bryson, electrical engineer, stated that, as far as he could calculate at present, the cost of constructing and equipping the horse tramways for electric traction would be about £15,000 per mile, and that the electric energy could be supplied by Leith to the company for about 1½d. per unit. As to the cost of extending the cable lines from Pilrig to the foot of Leith Walk, Mr. Kerr, of Messrs. Dick, Kerr & Co., promised to send to the town clerk of Leith a probable estimate of the cost. The tramways company, through Mr. Fleming, thought that in going into this question it might be as well not to attempt to equip all at once the tramway lines in Leith for electric traction, but to leave them to be worked with horses for, say, two or three years, which would enable them to work off their horses and plant. In the shape of horses and cars, there would be a saving to the Corporation and the company. The Leith deputation considered that this was not unreasonable. After conferring with the Leith Company, a further inter view will be arranged.

Liverpool.—Sir Francis Marindin has made a Board of Trade inspection of the Aintree and Fazakerley, Cabbage Hall and Oakfield Road, and the Stanley Road sections of the electric tramlines, and expressed satisfaction with the work.

Liverpool Overhead Railway.—The Liverpool Overhead Railway Bill now before Parliament contains powers to construct extensions of the present system in Seaforth, Bootle, and Toxteth Park. Power is also sought for widening the main line on both sides, commencing at a point 98 yards north of the north end of the western platform of the Pierhead Station, and terminating at a point 133 yards south of the north end of the platform.

London, S.E.—The South-Eastern Metropolitan Tramways Company has deposited a Bill for powers to construct over 11 miles of extensions, principally in Lewisham, including an extension from Rushey Green to South Norwood. It is proposed to carry out eight sections of street wideningsin Lewisham, Croydon, and Bromley, and power is sought to acquire certain lands near the Crystal Palace Gas Works on which to erect a generating station for the purpose of applying electrical traction throughout the company's system. Power is also sought to enter into agreements with the Corporation of Croydon, the Beckenham Urban District Council, and the Blackheath and Greenwich District Electric Lighting Company, Limited, for the supply of electricity in bulk. The new share and loan capital proposed to be authorised is £312,500, of which £62,500 may be raised on mortgage.

London Electric Railway Schemes.—The Brompton and Piccadilly Circus Railway Company are going for powers to extend the time for the compulsory purchase of lands and for the construction and completion of their railway.

The Baker Street and Waterloo Railway Company propose to extend their authorised railways to Bishop's Road, Paddington, in one direction, and in others to near Oakley Street, Westminster Bridge Road, to the Blind Schools, and to the New Kent Road, with subways for foot passengers at Bishop's Road, and to the Elephant and Castle Station of the City and South London Railway.

The Act authorising the City and South London Railway Company to make the underground railway to Islington, now in course of construction, limits the internal diameter of the station tunnels to 23 feet. The company now say that it would greatly facilitate the working of the traffic on the line if the tunnel for the station at the terminus at Islington were constructed of larger dimensions, and they are accordingly going to Parliament for powers to enable them to make that station tunnel with an internal diameter not exceeding 30 feet.

The Charing Cross, Euston and Hampstead Railway Company are going to Parliament for an extension of time for the compulsory purchase of certain lands, and for the construction of certain of their authorised railways.

Manchester to Liverpool.—A deputation of gentlemen interested in the promotion of the proposed electric railway between Manchester and Liverpool waited on 26th ult. on the Parliamentary Sub-committee of the Manchester City Council to submit plans of the undertaking so far as they may affect property within the city boundary. The Commiteee appointed the Lord Mayor and Mr. Alderman Southern to treat in future with the company's representatives.

The Metropolitan Railway and Electric Traction.—At the meeting of the Metropolitan Railway Company last week, Mr. John Bell referred to the electric traction question as follows:—"He might say, in regard to the experiments in electrical traction between Earl's Court and High Street, Kensington, that the board felt some disappointment that the experiments had not yet been completed. They were therefore unable to make any definite statement in regard to the result. The experiments had been generally conducted after the traffic had ceased at night, and on Sundays, but this was not a fair test, and the directors regretted that the experiments had not reached a stage which enabled them to make any communication to the proprietors as regarded any definite result. They might, however, rest assured that the question of the adoption of electrical traction was one which was exercising the board's very careful attention, and he might state that they had tried other experiments on a piece of line at Wembley Park, which, so far as they had gone, had given the directors and officials an amount of valuable information which could not have been obtained in any other way, and which would assist materially in solving the difficulties of applying electrical traction to the working of the railway. The board, moreover, considered that these additional experiments had been valuable in training the engineering staff at Neasden in the use of the new tractive power. The question of dealing with the cost of the experiments would be considered hereafter, and in all probability the proprietors would be recommended to charge it to the reserve fund." Sir E. H. Galsworthy expressed his opinion that the reserve fund was the right source from which to take the expenses that had been incurred in connection with the experiments with electrical traction. The chairman stated that the trains at Wembley Park, in connection with which the electrical experiments referred to had been made, were loaded, but, of course, not with passengers, the trains had been made up to the same weight, or a greater weight, than those which ran on their ordinary circle line. What the directors had desired to know in regard to the electrical experiments was the result of working by electric traction from day to day on a commercial basis, and he thought that the experience which had been obtained by them through the experiments at Wembley Park would enable them to judge whether the expense was justified.

Middlesex.—The estimated expenditure on electrical plant for the 37 miles of light railways proposed to be constructed by the Middlesex County Council exceeds £81,000.

Paris Metropolitan Railway.—The *Daily Chronicle* Paris correspondent says that the construction of the new metropolitan railway is being pushed forward with vigour in order that the line may be open for the Exhibition. The second series of tunnels, which will run between the Porte Maillot and the Place de la Nation, *viâ* the outer boulevards, has been begun. Parisians will be glad when the railway is finished, as many streets are now encumbered owing to its construction. The appearance of some suggests the barricaded boulevards of the Commune.

Plymouth.—The General Tolls Company, Limited, has presented a memorial to the Examiners of Private Bills complaining that the Plymouth, Stonehouse and Devonport Tramways Company has failed to comply with the standing orders in respect of the promotion of its Bill for next session. The memorialists complain principally of the clause in the Bill by which it is proposed to enable the company to use electrical power. This power, they contend, amounts, in this instance, to the making of tramways in the place of the existing tramways of the company, and that, therefore, the standing orders applicable to new tramways ought to have been complied with.

St. Helens.—On 30th ult. Mr. A. P. Trotter, an inspector of the Board of Trade, held an inquiry into an application of the Corporation for sanction to borrow £25,000 for an extension of the tramways in the borough and district. The town clerk (Mr. G. W. Bailey) explained that one loan of £25,000 had been sanctioned by the Board, but this had been overspent to the extent of £886 without the full proposals having been carried out. This was in consequence of necessary extensions of the generating plant. The extensions will cost £17,138, which, with £6 995 for extension of the generating station and the amount overspent on the original loan, would bring the total nearly to the £25,000. Mr. J. S. Highfield, electrical engineer, explained the details.

TELEGRAPH AND TELEPHONE NOTES.

Cable Rights in the Philippines.—A representative of the Eastern Extension Telegraph Company has submitted a notice of prior rights to the Commerce Committee of the American House of Representatives in the matter of the cable to the Philippines. It is maintained that the Spanish grants are binding on the United States, which could not lay a cable to Manila without extinguishing existing rights in some regular way. A Bill to pay the company its expenses for repairing the Manila-Hong Kong cable, cut by Admiral Dewey, was discussed in the House last week. No action was taken on it.

Glasgow Telephones.—In the Glasgow Court of Session last week judgment was given in the appeal case, City of Glasgow *v.* Order of Railway and Canal Commission. The Lord President said that on December 21st, 1898, the Postmaster-General required the Corporation within 21 days to give their consent to the placing of certain lines of telegraph in, under, upon, over, along, or across certain streets or public roads in Glasgow. On January 10th, 1899, the Corporation informed the Postmaster-General in writing that they were prepared to give their consent, provided the consent was not to be made applicable to the purposes of any private company or individual, whose application, if made direct to the Corporation, could be refused by them without right of appeal, and on February 17th, 1899, the Postmaster-General intimated in writing to the Corporation that he objected to the condition which the Corporation had attached to their consent. A difference thus arose between the Postmaster-General and the Corporation, and the difference was, under the Telegraph Act, 1878, referred to the Sheriff of Lanarkshire, and heard and determined by him. By his award, dated April 22nd, 1899, he awarded and ordered that the condition above mentioned ought not to be attached to the consent of the Corporation, and he further awarded, ordered, and consented that the Postmaster-General should be at liberty to place a line or lines of underground telegraphs in or under the streets mentioned in the notice dated December 21st, 1898, and along the routes therein specified. On May 5th, 1899, the Corporation gave notice in writing to the Postmaster-General that they were dissatisfied with the award of the Sheriff, and they thereby required that the difference which had arisen between the Postmaster-General and the Corporation should be referred to the Railway and Canal Commissioners. In the reference to the Railway and Canal Commissioners, the Postmaster-General contended that the condition attached by the Corporation to their consent was an unreasonable and improper condition, and that the order and award of the Sheriff that the condition ought not to be attached to the consent of the Corporation was reasonable and just, and further, that the consent given in the Sheriff's award was reasonable and just. In the reference to the Railway and Canal Commissioners, the Corporation submitted that the consent given in the Sheriff's award was unreasonable and unjust on account of the facts and reasons which they set forth in detail in their pleadings and evidence. By order, dated August 12th, 1899, the Railway and Canal Commissioners

determined that the conditions demanded by the Corporation ought not to be attached to the consent of the Corporation, and further ordered and consented that the Postmaster-General should be at liberty to place lines of underground telegraphs under the streets mentioned. By note of appeal, dated August 25th, 1899, the Corporation appealed to this Court against the order of the Railway and Canal Commissioners, and the Postmaster-General maintained that the appeal was incompetent. The Lord-President now said that he thought, and he gave reasons for his judgment, that the question brought before them by the appeal was not one of law, and, consequently, that they had no jurisdiction to entertain it. The other judges concurred. Replying to Mr. Johnston, for the Postmaster-General, the Lord-President said that there were two decisions against the Corporation already, and there could be no reason against giving expenses to the Postmaster-General.

The draft of the telephone license has been adjusted between the Corporation and the Post Office. It was approved at a meeting of the committee last week, and the minute came before the Town Council yesterday (Thursday).

The New German Atlantic Cable.—The first report of the German Atlantic Telegraph Company (Deutsch-Atlantische Telegrafen Gesellschaft) deals (says the financial press) at some length with the progress of the scheme for the establishment of an additional cable from Borkum, *viâ* the Azores, to New York. It appears that the company, which was formed in February, 1899, entered into an agreement in May of that year with the firm of Felten & Guilleaume and the German Government in regard to the matter, and some of the details of the arrangements will be of considerable interest in this country. The report points out that the concession granted by the Government to the firm for the establishment of the cable is for 40 years from the commencement of working, and that the laying of the cable is to be finished by October 1st, 1900. In case the cable is found to be inadequate for dealing with the traffic, the undertakers will be justified in laying a second cable for the duration of the concession. The German Postal authorities will operate the cable from the German terminal point, whilst the undertakers are to work and maintain the line at the Azores and on the North American side. The cable is in the first instance intended to deal with the telegraphic service between Germany or its Hinterlands and America and *vice versâ*, but Peru, Brazil, and the other South American States are excluded from its sphere of activity. As to the working of the line, the German Government will pay to the undertakers a fixed sum of £70,000 per annum until the expiration of the concession, and it will receive the revenue from messages sent in both directions between Germany and America to the extent of £85,000 per annum. When the receipts exceed £85,000 the German Government will, under certain conditions, participate in the excess at the rate of 25 centimes per word. The undertakers are pledged to take over the cable line of the Deutsche See Telegrafen Gesellshaft from Borkum to Vigo not later than by the end of 1904. After prolonged negotiations, the company has obtained permission to land the cable in the United States, whilst a landing position at the Azores has been secured through the intermediary of the European and Azores Telegraph Company, which will receive £2,500 for affording the necessary facilities. As soon as the working of the cable yields a dividend exceeding 8 per cent., the company undertakes to lay a cable between Fayal and Santa Maria, in the Azores. A further condition for the laying of the cable at the Azores was that the cable should be ordered from the Telegraph Construction and Maintenance Company. The cost of the cable, which will have a length of 4,366 nautical miles, amounts to £935,000, including laying. It is estimated that the cable, which is expected to deal with 8,000,000 words per annum, will be completed and set in operation before October, which month is specified in the agreement. Arrangements have been made with the Commercial Cable Company whereby the latter places its comprehensive network at the disposal of the company for the despatch of telegrams along the new cable to Germany, and provision has been made for the transmission of messages by other routes in case of any interruption in the working of the new cable. The capital of the new company, whose founders include the Schaffhausen Bankverein, the Dresden Bank, the Diskonto Gesellschaft, and the Darmstadt Bank, is £1,000,000, of which £700,000 has already been paid up.

The Pacific Cable.—The *Sydney Daily Telegraph* for December 14th says:—"H.M.S. *Egeria*, one of the Pacific squadron, recently returned to Esquimalt, having completed her survey for the proposed British Pacific cable. The ship had been absent on the work four months and three days. The nature of the *Egeria's* work, and, in fact, the result of it, as far as Honolulu, has already been published. That beyond was to a point north of the Fanning Islands, where H.M.S. *Penguin* left off work. Soundings were taken every 20 miles over the whole route, three being made a day and one each day on the return voyage. The course was as direct as it could be, and from Cape Flattery to Honolulu the distance was found to be 2,500 miles. The depth was very great, but averaged, it is understood, from 2,000 to 3,000 fathoms, one place having been found where 3,900 fathoms were measured."

A Reuter despatch from Toronto says that the British Empire League has passed a resolution, proposed by Sir Sandford Fleming, and seconded by Colonel Denison, urging that Canada should promptly ask the Imperial Government and the New South Wales Government to refuse assent to any agreement granting concessions to the Eastern Telegraph Company, unless provision were made for its cancellation if the public interests so demanded. The meeting declared its emphatic opinion that the Pacific cable scheme was of vital strategic importance to the Empire, and that the concession might prove its death blow.

Portsmouth Telephones.—The Finance Committee of the Town Council will not recommend the establishment of municipal telephones, but advises the Council to make arrangements with the National Telephone Company for a cheaper service.

Shanghai Telephones.—In January a prospectus of the China Telephone Company was in circulation at Shanghai, asking applications for share capital in that company, which proposed to obtain the Municipal Council's 30 years' franchise for establishing and working a telephone exchange system there. The nominal capital of the company is Taels 150,000.

The South African Cable Service.—"The Eastern Telegraph Company informs us that the East Coast cable to South Africa was repaired on the 12th inst., of which due notice was given through the International Bureau on the 13th inst., and the cable has since been working well. They also give notice that there is no delay on this cable owing to the West Coast line being broken, and that the repairing ship should have been over the break in the latter cable on Saturday evening." The above notice appeared in the *Times* of 29th ult. The statement as to the "due notice given through the International Bureau" does not seem convincing, as on consulting the *Journal Telegraphique* published by that Bureau, which is dated January 25th, we find that the Mozambique-Lourenço-Marques cable has against it a note to the effect that it is not yet repaired! The following is a list of recent interruptions to the cables which supply, or fail to supply, telegraph communication with South Africa:—

Section.	Date of interruption.	Date of repair.	Number of days down.
Laurenzo-Marques-Mozambique ..	31/10/99	15/11/99	15
Aden-Zanzibar	25/11/99	3/12/99	8
Laurenzo-Marques-Mozambique ..	18/12/99	12/1/00	25
St. Thomé-Loanda	11/12/99	15/12/99	4
" "	25/1/00	31/1/00	6

Thus from October 31st, 1899, till January 31st, 1900, a period of 92 days, one or other of the cables has been broken for a total of 58 days, or 63 per cent. of the time.

The St. Thomé Loanda cable has been repaired, and communication restored with South Africa by the West Coast routes.

The steamship *Anglia*, belonging to the Telegraph Construction and Maintenance Company, was to leave Greenwich on Monday morning with about 1,900 miles of cable on board for St. Vincent, where it is expected she will arrive about February 9th. After two days for coaling she will start towards Ascension, paying out the cable, and if all goes well, the section should be completed by February 24th. Mr. Frank Lucas, the engineer in chief, and Mr. Thomas Clark, the electrician in chief, are in charge of the *Anglia*, whilst the Eastern Telegraph Company is represented by Captain Pattison and Mr. Walter Judd.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired
West Indies:—		
Jamaica-Colon	June 30, 1899 ...	...
Trinidad-Demerara (1891 duplicate)	Oct. 23, 1899 ...	...
South African:—		
Mozambique-Lourenço-Marques	Dec. 17, 1899 ...	Jan. 26, 1900
St. Thomé-Loanda	Jan. 25, 1900 ...	Jan. 31, 1900
Cayenne-Pinheiro	Oct. 11, 1899 ...	...
Latakia-Cyprus	June 20, 1899 ...	...
Tarifa-Tangier	Jan. 2, 1900 ...	...
Serena-Valparaiso	Jan. 9, 1900 ...	Jan. 25, 1900
Landlines.		
West Indies:—		
Communication with Les Cayes (Haiti)	Nov. 21, 1899 ...	...
South African:—		
Communication with Mafeking and beyond	Oct. 13, 1899 ...	...
Communication with all offices beyond Orange River	Oct. 18, 1899 ...	...
Communication with north of Mooi River (Natal)	Oct. 22, 1899 ...	...
Communication with Colombia ...	Oct. 23, 1899 ...	...
Communication with Valentia (Venezuela)	Nov. 18, 1899 ...	...
Communication with all towns of United States of Colombia beyond Buenaventura	Jan. 22, 1900 ...	...
Saigon-Bangkok	Jan. 25, 1900 ...	...
Serena-Valparaiso	Jan. 16, 1900 ...	...

Telephone on the Congo.—A Press telegram from Brussels announces that telephonic communication has been established on the Congo Railway between Boma and Kwamouth, a distance of 450 miles.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bath.—February 12th. The Corporation invites tenders for high and low tension cables, arc lamps and posts, transformers, and sub-station and main works' switchboards. See "Official Notices" January 19th.

Bedford.—February 6th. The Corporation wants tenders for a surface condenser with air and circulating pumps, and engine for driving same. See our "Official Notices" January 26th.

Belfast.—February 8th. The Electric Committee wants tenders for 400-KW. steam dynamos. See our "Official Notices" January 5th.

Bootle.—February 17th. The Corporation wants tenders for underground electric cables. See "Official Notices" January 26th.

Bradford.—February 3rd. The Tramways Committee is inviting tenders for the complete electrical overhead equipment of about eight miles of tramway. Specifications, &c, at the City Surveyor's office, Town Hall, on payment of £3.

Coatbridge.—The Town Council is anxious to receive proposals from companies willing to lay down electric tramways. See "Official Notices" January 26th.

Dudley.—February 8th. The Corporation wants tenders for pumps, feed water heaters, and pipe work for the electricity works. See "Official Notices" January 26th.

France.—February 15th. Tenders are being invited, until February 15th, by the French Minister of Posts and Telegraphs in Paris for the supply of 585,250 metres of electric cables (paper insulated) in 12 lots. Tenders to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Glasgow.—February 5th. The Corporation wants tenders for two overhead electric travelling cranes for the tramway station. See "Official Notices" January 26th.

Glasgow.—February 17th. The Corporation is inviting tenders for the following:—(1) 200—300 motor car trucks; (2) 200—300 motors and equipments; (3) the supply, delivery, and erection complete of the overhead trolley constructional work required for the equipment of the system. Specifications, with form of tender, &c., and all other information, can be obtained on application to Mr. John Young, general manager, 88, Renfield Street, Glasgow. A bank draft for £5 5s., payable to the general manager, must be sent along with application for specification for each item. Deposits will be returned on receipt of a *bond-fide* tender. Sealed tenders, marked "Tramways, Tender for ——," must be lodged with the Town Clerk, City Chambers, Glasgow, by February 17th.

Great Yarmouth.—February 15th. The Corporation wants tenders for two water-tube boilers and three 200-KW. continuous current steam dynamos. See "Official Notices" Jan. 19th.

Hastings.—February 12th. The Corporation wants tenders for 12 20-KW. alternating current transformers and sub-station switch gear. See "Official Notices" January 26th.

Horsham.—March 1st. The Urban District Council is wanting tenders for water-tube boilers, pipework, two steam dynamos, batteries, switchboard, 6-ton overhead traveller, mains, road work, enclosed arcs, and station lighting. See "Official Notices" January 26th.

Hull.—February 19th. The Corporation wants tenders for 35 double motor equipments and 10 car bodies. See "Official Notices" January 26th.

Inverness.—February 8th. The Town Council wants tenders for two 200-KW. steam dynamos, fuel economiser, motor balancer and booster, battery, three water-tube boilers, overhead traveller, switchboards, station lighting, arc lamps, feeders and distributors, joint and service boxes and service cables, meters, tools, &c. See "Official Notices" January 26th.

Keighley.—February 3rd. The Corporation wants tenders for two Lancashire boilers, mechanical stokers, economisers, feed pumps, one 120 and one 200-KW. high speed continuous current steam dynamos. See "Official Notices" January 19th.

Leyton.—February 14th. The Electric Lighting Committee wants tenders for a switchboard for the new electric light works. See "Official Notices" January 19th.

London.—February 5th. The Postmaster-General is inviting tenders for underground work, including laying conduits and pipes for telephone purposes in several parts of the metropolis. See "Official Notices" January 19th.

Melbourne.—March 1st. The Corporation is wanting tenders for boilers, engines, dynamos, switchboard, feeders, mains, arc light leads, accumulators, &c., for electric lighting. See "Official Notices" December 22nd.

Newcastle-on-Tyne.—March 2nd. The Tramways Committee wants tenders for 130 car bodies, trucks, and electrical equipment for same. See "Official Notices" to-day.

Newington.—February 20th. The Vestry wants tenders for two water-tube boilers, feed pump and extensions to steam and water mains at the electricity works. See "Official Notices" to-day.

Rochdale.—February 28th. The Corporation wants tenders for electricity meters. See "Official Notices" to-day.

Stoke-upon-Trent.—February 13th. The Guardians want tenders for the electric lighting of a portion of the workhouse premises. See "Official Notices" January 19th.

Sunderland.—The Corporation wants tenders for a tramways switchboard. See "Official Notices" January 12th.

Tunbridge Wells.—February 5th. The Corporation wants tenders for the supply of two Lancashire boilers for the electricity works. See "Official Notices" January 19th.

Walthamstow.—February 23rd. The District Council wants tenders for the supply of electric lighting and Dowson gas plant at the Isolation Hospital, Chingford. See "Official Notices" to-day.

York.—The Corporation invites tenders for the conversion of the wiring of the Courts of Justice to suit higher voltage. See "Official Notices" January 26th.

CLOSED.

Aberdeen.—The Gas and Electric Lighting Committee has accepted the offer of the British Westinghouse Company to supply an engine and dynamo at a cost of £5,092. The engineer's report as to the proposed new works was deferred to a special meeting. A sub-committee was appointed to inquire into the alleged smoke nuisance in connection with the works at Cotton Street.

Bedford.—At a meeting of the Town Council on the 24th ult., the tender of Messrs. W. H. Allen & Son for a 420-B H.P. engine, at a cost of £1,600, and that of Messrs. Rosling & Appleby for a 250-KW. alternator for £1,200, was accepted.

Birkenhead.—The order for the mechanical stokers, including a special motor for driving same, for the Birkenhead electric light station, has been received by Messrs. W. B. Haigh & Co., Limited.

Glasgow.—At a meeting of the Tramway Committee last week the following contracts were fixed in connection with the new power station at Port Dundas:—Tunnel under the canal, Morton and Anderson, Glasgow, £1,400; steel flues, Mechan & Sons, Glasgow, £4,095; water storage tanks, Hanna, Donald, & Wilson, Paisley, £725; coal and ash conveying plant, Mirrlees, Watson & Yaryan Company, Limited, Glasgow, £9,900; mechanical stokers, eight pairs to Babcock & Wilcox, Limited, Renfrew, and eight pairs to Vickers and Co., Manchester.

Hackney.—The Vestry has placed the refuse destructor contract with Messrs. Hughes & Stirling, of Arundel Street, W.C., at £24,495, this being the lowest tender in strict compliance with the specification.

Manchester.—The Electricity Committee has decided to accept a tender to supply two generators, each of 1,000 H.P., for the electric station, at a cost of £9,000.

Shoreditch.—The Vestry has contracted with Messrs. McFarlane & Co. for the supply of 32 lamp columns, at £4 10s. each.

Southampton.—The Tramways Committee has contracted with Messrs. Macartney, McElroy & Co., Limited, at £225 10s. for lighting the Shirley tramway depôt by electricity.

Wrexham.—The Council on Tuesday accepted the following tenders in connection with the electricity supply works:—Messrs. Babcock & Wilcock, £2,527; the Lancashire Dynamo and Motor Company, £7,286 10s.; Messrs. Brook, Hirst & Co., £589; the St. Helens Cable Company, £4,499 11s. 7d.; the Chloride Company, £991; Messrs. Carrick & Ritchie, £140; Messrs. Davies Brothers, £1,112, for alteration of buildings.

York.—The tenders submitted for electric wiring at the Guildhall and municipal offices numbered 21, and ranged from £87 3s. to £730, those for the Mansion House ranging from £79 18s. 9d. to £282. These figures are about the most remarkable we have ever seen; of course, we make this remark in the absence of information as to whether tendering was done to one specification, and as to how far the stipulations contained therein were adhered to by the tenderers. Some of them quoted for wood casing, others for Simplex, brazed, and steel tubings. The contract for both the offices and the Mansion House has been given to Messrs. Ensor, Brentnall & Co., at £154 13s. and £144 17s. respectively.

FORTHCOMING EVENTS.

Friday, February 2nd.—Royal Institution. Mr. G. Marconi lectures on "Wireless Telegraphy."

Institution of Junior Engineers. Paper on "Arc Lamps and Arc Lighting," by H. G. Cotsworth.

At 2.30 p.m. Institution of Civil Engineers. Students visit to the electrical works of the London United Tramways, Limited, Chiswick.

Monday, February 5th.—At 7.30 p.m. Society of Engineers (Royal United Service Institution, Whitehall). Presentation of premiums. Inaugural address by Mr. Henry O'Connor.

Thursday, February 8th.—At 8 p.m. The Institution of Electrical Engineers. "The Standardisation of Electrical Engineering Plant." By R. P. Sellon, member.

Friday, February 9th.—At 5 p.m. Physical Society. Annual general meeting. Address by the President, Prof. O. J. Lodge, D.Sc., F.R.S.

Saturday, February 10th.—The Institution of Electrical Engineers. Students' visit to Messrs. Siemens, Bros. & Co's Works, Woolwich. Train leaves Charing Cross for Charlton at 9.20 a.m.

Friday, February 16th.—At 7 p.m. Northern Society of Electrical Engineers. Annual dinner at the Grand Hotel, Manchester, Mr. Ferranti presiding.

Wednesday, February 28th.—At 8 p.m. Society of Arts. Prof. Carus-Wilson on "The Electrical Induction Motor on Mountain Railways."

HOMES FOR DISCHARGED SOLDIERS.

WE have been asked to bring before our readers a project which cannot fail to appeal to their sympathy. Amid the excitement and clamour of warfare, which are brought vividly home to us by the space-destroying telegraph, and the parting cheers to our brave soldiers as they set out in health and strength to southern shores, we are too apt to forget the reverse of the picture—the fever-stricken invalid, the maimed and battered soldier who has offered his life and given his very limbs, his means of livelihood, for his country, and returns with no brighter prospect than that of dragging out his days on a meagre pittance, barely sufficient to keep body and soul together!

We can do nothing for the heroes who have yielded up their lives in our behalf; but we *can* provide for these victims of the strife, and it is our bounden duty to do so to the best of our ability.

With this object in view, at the suggestion of Mr. Edwin O. Sachs, an influential committee has been formed, consisting of leading representatives of the building trades; and it has been decided to erect and equip six cottage homes, containing 100 beds, together with a large recreation-room and workshop, and the necessary offices, and to present them as the Building Trades' Gift to the Nation.

The gift is primarily intended to take the form of contributions *in kind*, but where this is not possible or convenient it is hoped that firms will assist with cheques, to meet such needs as cannot be gratuitously supplied.

The administrative work and the construction of the homes will be in the hands of a small executive, of which Mr. T. F. Rider is the honorary secretary, with offices at 1, Waterloo Place, Pall Mall, S.W. Mr. Max Byng has been appointed honorary steward for the electrical section of the undertaking, and will be glad to receive contributions in kind.

The publishers of the ELECTRICAL REVIEW, Messrs. H. Alabaster, Gatehouse & Co., have been requested by the steward to act as honorary treasurers to the fund for the electrical section, and will gratefully acknowledge all cheques that may be forwarded.

It is proposed also to publish in the ELECTRICAL REVIEW the list of contributions, whether cash or otherwise, as received or notified.

We reproduce below a schedule of the materials which will be required. Further particulars may be obtained from the steward, whose offices are at 69, Queen Victoria Street, E.C.

It would be invidious to select, from the list of donors who have already contributed, any names in particular; but we may say that up to the 31st ult. huge quantities of bricks, slates, cement, lime, ironwork, woodwork, slagwool, doors, kitchen ranges, paint, &c., had been promised, as well as over £300 in cash.

Arrangements have been made by which workmen who sympathise with the scheme will be enabled to assist, the whole of their contributions being devoted to the cost of the labour of erecting the buildings.

Transvaal War.—Building Trades' Gift to the Nation.

Homes for Discharged Soldiers.—Specification for Electric Lighting.

LARGE BUILDING.

There are seven of these buildings. (Six homes, one special block.)

GROUND FLOOR.

	8 Pts.	16 C.P.	C.P.	SW.
Lobby.—1 2-light ceiling or lantern fitting	1	..	2	1
Outside Front Door.—1 1-light wrought-iron bracket	1	..	1	1
Hall.—1 1-light hall fitting	1	..	1	1
1 1-light pendant with fancy shade	1	1	..	1
Dining Room.—4 8-light ball pendants or electroliers with fancy shades	4	..	12	4
Reading Room.—1 8-light ball pendant or electrolier with fancy shades	1	8	1	..
Caretaker's Room.—1 2-light ball pendant or electrolier with fancy shade	1	..	2	1
1 wall plug with small standard lamp	1	..	1	..
W.C.'s.—2 1-light halfway bulkhead fittings	2	2	..	2
Passage Lobby.—3 1-light enamelled shade pendants	3	3	..	3
Corridor.—1 enamelled shade pendant	1	..	1	1
Two Bath Rooms.—1 enamelled shade pendant in each	2	2	..	2
Locker Room.—2 enamelled shade pendants	2	2	..	2
Stores.—1 enamelled shade pendant	1	1	..	1
Boxes, Boots.—2 enamelled shade pendants	2	2	..	2
Verandah.—4 1-light brackets, or pendants with metal down rod, and shades	4	4	..	4

FIRST FLOOR.

Halfway Landing.—1 enamelled shade pendant	1	1	..	1
15 Bedrooms.—1 enamelled shade pendant in each	15	15	..	15
Caretaker's Bedroom.—1 enamelled shade pendant	1	..	1	1
1 wall plug with small standard lamp	1	..	1	..
Corridor Upper Hall.—4 enamelled shade pendants	4	4	..	4
Sink and W.C.—1 halfway bulkhead fitting	1	..	1	1
Senior Bedroom.—1 enamelled shade pendant	1	..	1	1
Bedding.—1 Enamelled shade pendant	1	1	..	1
Each of seven houses	58	41	24	51

SMALL BUILDING.

There are three of these buildings.

GROUND FLOOR.

Scullery.—2 enamelled shade pendants	2	..	2	2
Servants' Hall.—2 enamelled shade pendants	2	..	2	2
Kitchen.—3 enamelled shade pendants	3	..	3	3
Larder.—1 enamelled shade pendant	1	..	1	1
Corridor.—2 enamelled shade pendants	2	2	..	2
By Stairs.—1 enamelled shade pendant	1	1	..	1
W.C.—1 enamelled shade pendant	1	1	..	1
Two Covered Ways.—1 enamelled shade pendant in each	2	2	..	2

FIRST FLOOR.

Two Nurses' Rooms.—1 enamelled shade pendant in each	2	..	2	2
Servants' Room.—2 enamelled shade pendants	2	..	2	2
Box, Landing, Corridor.—1 enamelled shade pendant in each	3	3	..	3
Two Covered Ways.—1 enamelled shade pendant in each	2	2	..	2
Total of three houses	23	11	12	23

There are three *blocks* of buildings, each comprising *two* large buildings, and *one* small building in the centre, connected together by covered ways on each floor, 20 feet long. There is also one large building alone.

The mains are brought from the engine room underground direct to the different blocks. The large blocks of three buildings have each one distributing board, dividing its own block into five circuits, as follows:—

1.	Circuit.—Ground floor,	left hand large building	14½	amperes.
2.	" "	right " "	14½	"
3.	" First floor	left " "	7	"
4.	" "	right " "	7	"
5.	" Small building		8	"

The single building has a distributing board dividing its block into two circuits:—

1.	Circuit.—Ground floor	14½	amperes.
2.	" First floor	7	"

Each distributing board circuit is divided into 5 ampere circuits, or less.

COMPLETE QUANTITIES FOR THE INSTALLATION OF ELECTRIC LIGHT

UNDERGROUND CONDUITS.—200 feet to carry 3 pairs 19/16 cable, and 1 pair 7/16 cable; 415 feet to carry 1 pair, 19/16; 125 feet to carry 1 pair, 7/16.

CABLE.—770 yards 19/16, insulated or bare, according to material of conduits; 200 yards 7/16, insulated or bare, according to material of conduits; 39 coils, 7/21½ cable, 600 megohms; 18 coils, 3/20 cable, 600 megohms; 53 coils, 3/22 cable, 600 megohms; 3 coils, 7/17 cable, 600 megohms; 3½ coils, 7/19 cable, 600 megohms.

CASING AND CAPPING.—10,000 feet 1½ inches; 6,000 feet 1¾ inches; 500 feet 2½ inches; 500 feet 2¾ inches.

426 5-ampere switches; 900 blocks for above switches, plugs, and ceiling roses; 14 5-ampere plugs; 14 2-light ceiling or lantern fittings, complete, with flex lampholders and shades; 7 wrought-iron brackets, water-tight, for outside, complete, with lampholders and shades; 95 3-light ball pendants or electroliers, complete, with lampholders, flex, and shades; 7 3-light ball pendants or electroliers, complete, with lampholders, flex, and shades; 14 small standard lamps, complete, with flex, lampholder, and shades; 21 bulkhead fittings (halfway), complete, with lampholders and shades; 28 brackets or metal down-rod pendants, complete, with lampholders and shades; 307 ceiling roses; 307 lampholders, with cord grip and shade carrier; 307 enamel iron shades; 7 fancy shades for hall lighting; 2¼ gross yards flexible wire; 70 5-ampere cut-out; 7 3-way 5-ampere sub-circuit boards, with D.P. fuses; 10 2-way 5-ampere sub-circuit boards, with D.P. fuses, made up of 1/20 and 1/10 ampere circuits; 8 5-way distributing boards, with D.P. switches and fuses, made up of 2/20-ampere and 3/10-ampere circuits; 1 2-way distributing board, with D.P. switches and fuses, made up of 2/20-ampere and 3/10-ampere circuits; 4 lbs. India-rubber strip; 6½ tins I.R. solution; 4 lbs. prepared tape; 30 lbs. solder; 5 lbs. resin.

50 gross screws, ¾ inch, No. 4; 30 gross screws, 1 inch, No. 6; 15 gross screws, 2½ inches, No. 10; 10 gross screws, 2 inches, No. 8.

56 lbs. French cut nails, 2½ inches; 7 lbs. French cut nails, 3 inches.

3 D.P. main switches, 75 amperes; 3 D.P. main fuses, 75 amperes; 1 D.P. main switches 25 amperes; 1 D.P. main fuse, 25 amperes; 204 16-C.P. 100-volt lamps; 320 8-C.P. 100-volt lamp. Note.—It is desirable that the lamps should not take more than 3 watts per candle-power. The above quantities of accessories are only what are necessary. Some spares would be acceptable.

PLANT.

It is desired to lay down a plant of nearly double the capacity of what is at present required, with the exception of the accumulator set, and for the sake of economy in running it would be desirable to have two small complete duplicate sets of plant, as follows:—

Two 12½-KW. dynamos, shunt or compound wound, giving 135 volts when running on the accumulators, and 100 volts when running with compound winding, complete with field rheostats. Two 16—17-B.H.P. steam engines. Two 5—6-N.H.P. boilers with injectors and donkey pumps; steam pressure to suit maker of engines and boilers; tools, &c. One battery of accumulators, 150 amperes maximum output for eight hours, say, 1,200 ampere-hours. Switchboard with necessary instruments and switches for running the two dynamos in parallel, or separately on the accumulators or on the mains, with four circuit switches, three of 75 and one of 25 amperes; also spare circuit switches for extension of about similar dimensions. Necessary steam and water piping. Belting for driving dynamo if machines are not coupled direct to engine.

Engine room installation:—Eight enamelled shade pendants; two wall plugs and hand lamps. Note.—The material for these lights is not included in the quantities, and they should be wired from a circuit completely independent of those of the main installation.

THE LATE PROF. HUGHES.

By J. MUNRO.

The life and work of Prof. Hughes are so well known to the reader that I shall only refresh his memory with the more salient facts.

David Edward Hughes was born in London of Welsh parents in 1831, and seven years later emigrated with them to Virginia. The boy inherited from his father an extremely fine musical ear and a gift for improvising tunes, which in 1850 led Hast, a famous German pianist in America, to get him the professorship of music in the College of Bardstown, Kentucky.

Nature had endowed him with another talent, however, and the study of science began to allure him from the career of a musician. He was offered the Chair of Natural Philosophy in his college, and for a time he taught both music and physics, but the idea of his printing telegraph came to him one evening while he was composing, and altered his way of life. The most captivating work to an original mind is the conception and execution of a new idea that is worthy of it. The Professor grew so much absorbed in his experiments, that he grudged the hours he spent on the routine of his classes, and in 1853, to gain more freedom, settled in Bowling Green, Ky., where he took private pupils.

Here in those early days he was forced to rely on himself, and the principal organs of the new telegraph were of his own device. This habit of creating his own tools and experimenting with the simplest means was characteristic of him, and an encouragement to the poorest aspirant. In 1854 he went to Louisville, Ky., and superintended the construction of the first instrument. It was patented next year, adopted by the New York Associated Press, and ultimately acquired by the Western Union Telegraph Company. In 1857 Hughes came to England, but failing to get the Electric Telegraph Company to employ it, in 1860 he crossed to Paris, where fame and fortune awaited him. The French Telegraph Administration were delighted with it, and Napoleon III. created him a Chevalier of the Legion of Honour. The example of France was followed by Italy in 1862, by the United Kingdom Telegraph Company in 1863, by Russia and Prussia in 1865, Austria and Turkey in 1867, Holland in 1868, Bavaria and Wurtemburg in 1869, Switzerland and Belgium in 1870, by the Submarine Telegraph Company, of London, in 1872, and by Spain in 1875. At St. Petersburg he was the guest of the Czar, who gave him the Order of St. Anne; from the Emperor of Austria he received the Order of the Iron Crown; from the Sultan the Grand Cross of the Order of Medjidieh; from Bavaria the Noble Order of St. Michael; and in Spain he became a Commander of the Royal and Distinguished Order of Carlos III.

Laden with these tributes, he returned to his birthplace, and laying them aside, lived as a humble citizen in modest apartments.

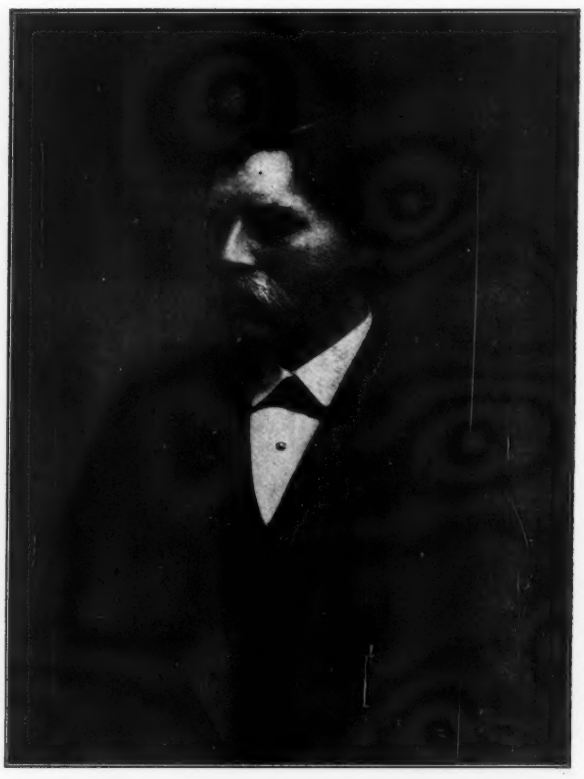
Genius, however, is not easy to hide, and after a short rest he, in 1877, discovered the microphone, which compelled even his own country to acknowledge him. The microphone led him on to other researches, and in 1879 was followed by the induction balance and sonometer. Towards the end of this year he also discovered the Hertzian waves before Hertz, the Branly "coherer" before Branly, and the "wireless telegraph" before Lodge, Marconi, and others, but owing to an unfortunate difference of opinion between him and Prof. Stokes these great advances, perhaps the most epoch-making of his life, were unreported, and so lost to the world for nearly 20 years. [See Electrical Review, June 2nd, 1899, "The experiments

of Prof. Hughes on Ether Telegraphy."] He lived to see them justified, however, and as time goes on he will doubtless be recognised as the true pioneer of wireless telegraphy.

His last important contribution to electrical science was a paper contributed to the Royal Society of London on the nature of magnetism.

After the production of the microphone he was invited to become a Fellow of the Royal Society, and in 1885 he was awarded the Royal medal of the Society for his experiments. In 1881 he was a British Commissioner at the Paris Electrical Exhibition, and president of a section of the International Congress of Electricians. In 1886 he was elected president of the Society of Telegraph Engineers, now the Institution of Electrical Engineers, and latterly he became one of the managers of the Royal Institution. Lesser men have been honoured with titles by the Government, but he never courted the great, and, like Faraday, was all the greater for his disregard of pomp.

He enjoyed good health in general, but some two years ago a giddiness, which made him fall, led his devoted wife to prevail upon him to consult a physician. It developed into a partial paralysis of one side of the body, which confined him, very much against his will, to the house, but could not quench his deep thirst for science, or keep him from joking with the doctor about his "dummy" hand. Although he recovered from the first attacks and was able to go about, the ailment hung about him, and recently a cold, followed by influenza, overloaded his already shaken constitution. On Monday, January 22nd, after a difficulty in breathing, he fell into a gentle sleep from which he never awoke. Apparently his heart stopped like a watch, and there was no change in the peaceful serenity of his countenance.



Prof. Hughes in 1878.
[Specially taken for the Electrical Review by Mr. J. E. Mayall.]

Steps will probably be taken to commemorate his generous and beneficent services, and his connection with the Institution of Electrical Engineers and the Royal Institution, by the installation of a marble bust or an oil portrait in the rooms of these societies. The artist could hardly wish for a better model than his intellectual and striking head, which combined the traits of a musician and an inventor.

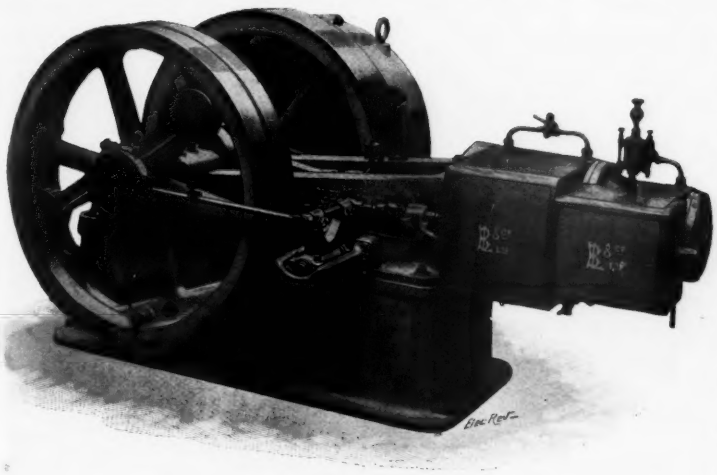
He was a very likeable, indeed, a lovable character. It is better to be loved than admired, and in thinking of Prof. Hughes, it is rather his heart than his head that interests us; rather the man than the philosopher that we mourn. His genial kindly face and manner endeared him to his friends, and charmed his acquaintances. His ready wit and ingenious turns of thought, his unaffected, even child-like simplicity, and good-natured laugh, so stingless and free from all offence, will never be forgotten by those who joined the little party which used to meet him at luncheon in Frascati's restaurant. He was always the life and soul of the circle, and his absence caused a feeling of disappointment as when a cloud obscures the sunlight.

Latterly his health grew uncertain, and made it necessary for him to nurse himself, but he seemed to retain his cheerfulness and kindliness to the last. With all his experience and wisdom, his heart was boyish, and he exemplified the saying that men of genius never grow old, except in body.

In losing him electrical science has lost one of its grandest ornaments, and he shared with Lord Kelvin the place of highest honour in the electrical profession of this country. If Kelvin's life has been vaster, and his activity more multifarious, more than one of the really glorious discoveries and inventions of our electrical age have fallen to the happy and prosperous, yet retiring, lot of Prof. Hughes.

The remains of Prof. Hughes were borne to their last resting place on Saturday last, and electrical and other scientists attended in goodly numbers to pay their final tribute to one who had in his lifetime served passing generations with conspicuous ability, and whose labours will ever leave indelible footprints in the sands of time. The gathering at the memorial service at All Souls', Langham Place, was truly representative of the great choir of science, that world-wide choir in which the Professor's voice—now for ever silenced—once filled a noble part. Lord Lister, as representative of the Royal Society, Sir Frederick Bramwell, for the Royal Institution, Prof. S. P. Thompson, for the Institution of Electrical Engineers, Lord Kelvin, Sir William Crookes, Prof. Dewar, Dr. J. H. Gladstone, Dr. Johnstone Stoney, Sir Henry Mance, Major Crompton, Prof. A. W. Rucker, Prof. Perry, Prof. Meldola, Sir F. Abel, Sir H. Trueman Wood, Maj.-Gen. Webber, Prof. Spooner, Mr. Alex. Siemens, Mr. A. B. Kempe, Mr. C. Hawkesley, Mr. J. Swinburne, Mr. J. Wimshurst, Mr. E. Clodd and Major Adams (executors), the American Ambassador, the Servian Consul, Mr. H. Alabaster, Mr. C. E. Spagnoletti, representatives of the Duke of Northumberland (as president of the Royal Institution) and Sir W. H. Preece, Mr. H. Edmunds, Mr. C. Bright, Mr. G. L. Addenbrooke, Mr. F. H. Webb, Mr. A. P. Trotter, Mr. R. K. Gray,

Mr. P. V. Luke, Mr. W. M. Mordey, Mr. W. G. McMillan (secretary of the Institution of Electrical Engineers), and Mr. Augustus Stroh were present either at the memorial service or at the interment at Highgate Cemetery.



150-H.P. Tandem Compound Engine with Begtrup Fly-wheel Governor.

The mere mention of these names indicates how widely the late professor was respected, and what a large number of friends he had made. At Highgate Cemetery the coffin was deposited in the Lebanon Catacombs. Special request had been made that there should be no flowers, but kind hands had ornamented the interior of the vault with palms, arum lilies, lilies of the valley, and a choice variety of other flowers.

COVENTRY ELECTRIC TRAMWAYS.

Since our description of the Coventry tramway system as it was in 1896, large changes have taken place; a new generating station has been built, the plant extended, and new routes have been opened for traffic.

The number of cars in regular running is now 16, while on special occasions 20 motor cars and five trailers are put in service. The length of line amounts to 8½ miles single track, and 2 miles double track, the latter being the total length of the turnouts; the ruling curves are of 40 to 60 feet radius, and the maximum grade is 1 in 12, 60 yards long.

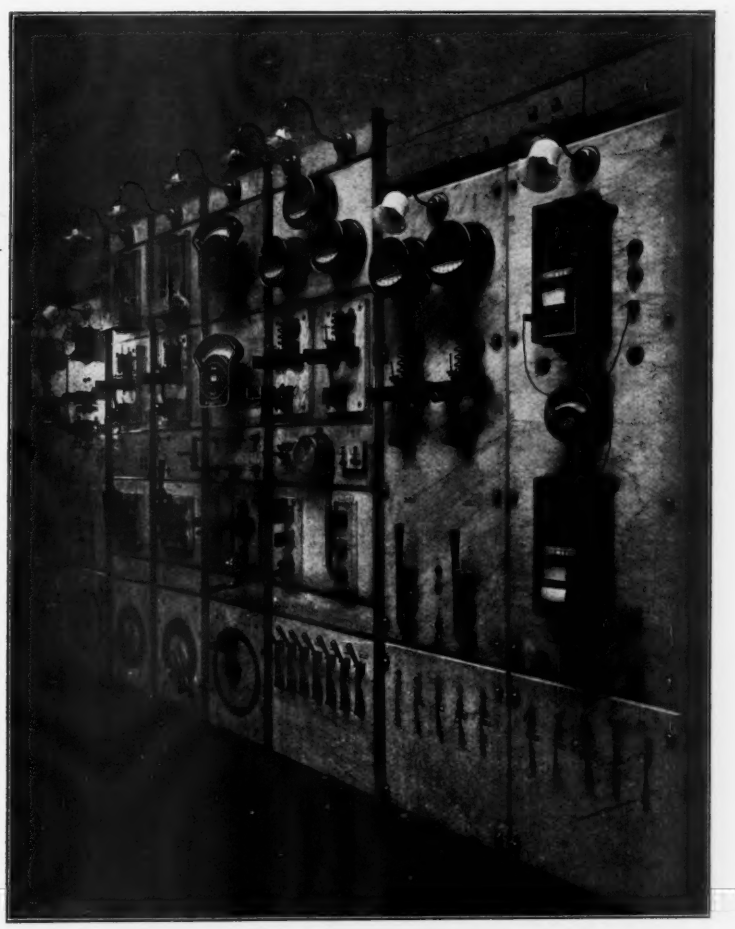
The new power station is situated in a central position, and was erected to the designs of the New General Traction Company, Limited. The engine room is 25 feet wide by 80 feet long, and the boiler room 40 feet by 60 feet; the stack is 100 feet high, 6 feet 4 inches diameter at the top, and is based on a concrete foundation 22 feet square.

There are four Babcock & Wilcox boilers, two of 172 H.P., and two of 106 H.P., fitted with Bennis patent mechanical stokers and endless chain conveyor; the latter carries the coal direct from the coal store alongside the canal. The grates are of the open ash-pit type, with Messrs. Bennis & Co.'s patent steam-jet fire-bars. The station is in the happy condition of having a good demand for ashes, which not merely cost nothing for removal, but are paid for!

A Green's economiser, of 240 tubes, is provided; the scrapers are driven by a small steam engine, formerly used for lighting at the old station, and which also drives the stoking machinery. There are three Worthington pumps, each of which can feed three boilers; the make-up water is drawn from the town mains, with the canal as an alternative. The condensed water is passed through a Raylton & Campbell filter to free it from oil.

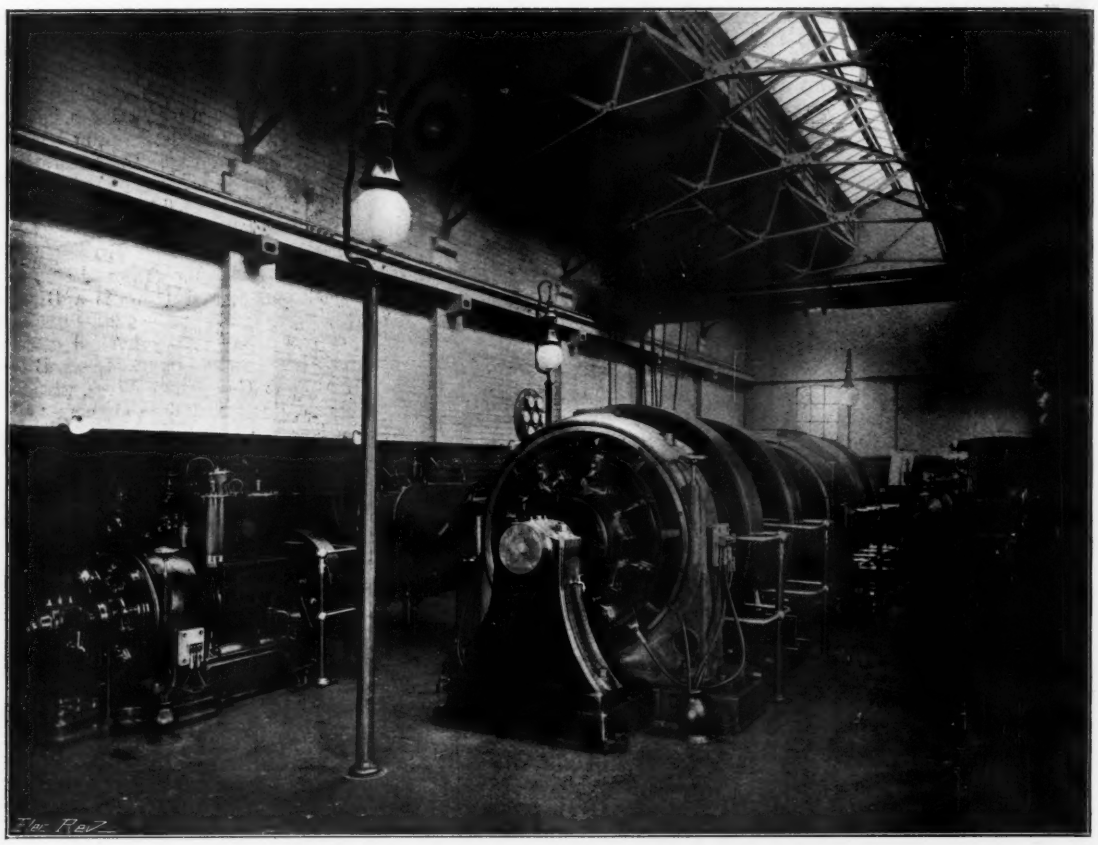
The steam pipes form a ring main, with Powell stop valves and Lancaster steam traps; some Lindley & Carter stop valves are also used, and there is a Berryman feed water heater in the engine room.

The whole of the engine and condenser work was carried out by Messrs. Browett, Lindley & Co. The engines, which were originally installed were simple and non-condensing; these have been compounded by the addition of high-pressure cylinders in tandem with the others, and are now run condensing at 150 H.P. each. They have also been fitted with new fly-wheels, with which are combined governors of the Begtrup type; this is clearly seen in the illustration of one of the new engines. The old ones drive the original generators by leather belts, 15 inches wide, with cemented joints, which run with remarkable smoothness. The two new engines are coupled direct to their generators, and run at 250 revolutions per minute, developing 150 H.P.

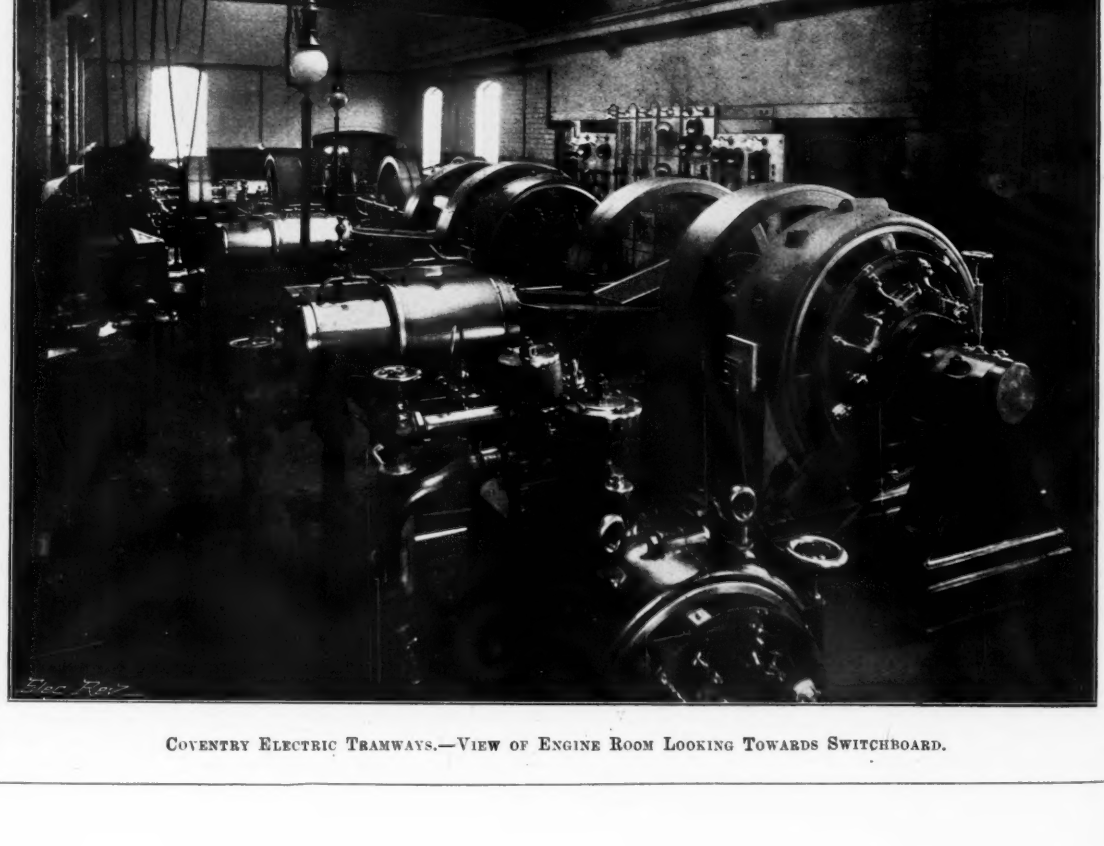


Main Switchboard.

each. The cylinders of the latter are 13 inches and 19 inches in diameter, with 13 inches stroke. The Begtrup shaft governor, which is the subject of patents owned by Messrs. Browett, Lindley & Co., is being largely applied to their

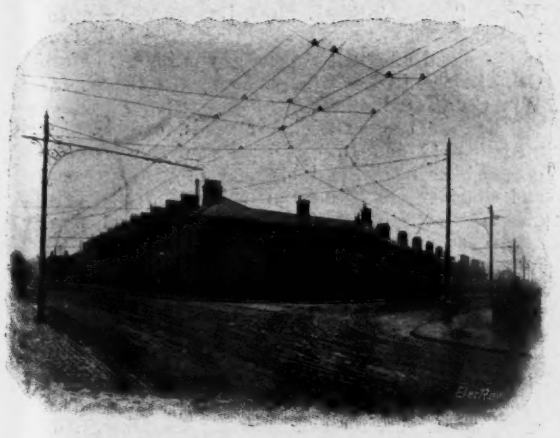


Coventry Electric Tramways.—General View of Engine Room.



Coventry Electric Tramways.—View of Engine Room Looking Towards Switchboard.

engines for electric traction and transmission of power, on account of its high sensitiveness and quick action under extreme variations of load. Both high and low pressure



Overhead Construction: Curve and Junction.

valves are actuated by the one spindle, which is directly controlled by the governor, so that the cut-off and compression in *both* cylinders are immediately altered upon a change occurring in the load. The stuffing box between the two valve-chests is packed with U.S. metallic packing, and although it is inaccessible without removing the cover of the valve-chests, we were informed that it gave no trouble.

The older generators are of the four-pole type, running at 650 revolutions per minute; the others are six-polar, running at 250 revolutions per minute; all are of the Westinghouse Company's manufacture and are rated at 100 KW. each.

Besides the four large sets, a small lighting set, consisting of a Westinghouse single-acting engine and dynamo, has been provided for use after the traction generators have been shut down; as the dynamo runs at 500 volts, it is available for working the shop motors if required at night, besides lighting the car sheds, power station, and any part of the track where work is being carried on. The dynamo is multipolar, of 17 KW. output, and runs at 400 revolutions per minute.

The condensing plant, which is fixed in a pit in the floor of the engine room, is in duplicate, each set consisting of a surface condenser of 450 feet surface, and a pair of balanced vertical air-pumps driven through single reduction double helical gearing by a steam engine.

The air-pump barrels are 12¼ inches diameter, with 8 inches stroke, making 100 double strokes per minute when the engine runs at 300 revolutions per minute. A centrifugal pump, made by Messrs. Drysdale, is driven from the fly-wheel of the engine by means of a belt, and draws water from the canal at one point, circulates it through the condenser, and returns it to the canal at another point. With the exception of the centrifugals, the whole plant was made and erected by Messrs. Browett, Lindley and Co., Limited. Each set is capable of dealing with all the steam from the engines when indicating 300 H.P. Although the plant is situated below the floor level, it is so arranged that every part is readily accessible, and the condenser tubes can easily be withdrawn. An automatic relief valve is provided for atmospheric exhaust in case of need.

The main switchboard, of Westinghouse tpye, consists of eight panels—four generator, two feeder, one lighting, and one Board of Trade—and is at present incomplete, the ornamental border and clock being lacking. The panels are of marble, and are equipped with the usual apparatus. Two of them were in use in the old station, and are provided with triple main switches, but on the newer panels the equaliser switch is combined with the circuit breaker. A Thomson-Houston watt-hour meter is in circuit with each dynamo, behind the board, and Wurts non-arcing lightning arresters, described in our issue of January 5th, are in use.

The 5-ton overhead traveller was supplied by Messrs. Jessop & Appleby.

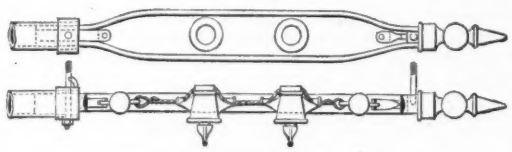
The track rails are of the girder type, 6 inches high, and weigh 65 and 84 lbs. per yard; they are carried on steel sleepers 10 feet apart, to which they are secured with clips.

The Falk cast-welding system has been adopted for the rail joints on the new sections, as well as on a large part of the original tracks. The rails are cross-bonded with Chicago bonds.

Most of the new overhead construction has been carried out on the side bracket system, with centre trolley; the arms are, therefore, very lengthy. The insulators are supported by bow-strings fixed in harps, which were designed by Mr. I. E. Winslow, chief engineer; one form of these is illustrated on p. 190. Rosette and side pole cross suspension is also used in places. The height of the trolley wire, owing to bridges, &c., varies from 16 feet to 22 feet; to maintain an even pressure of the

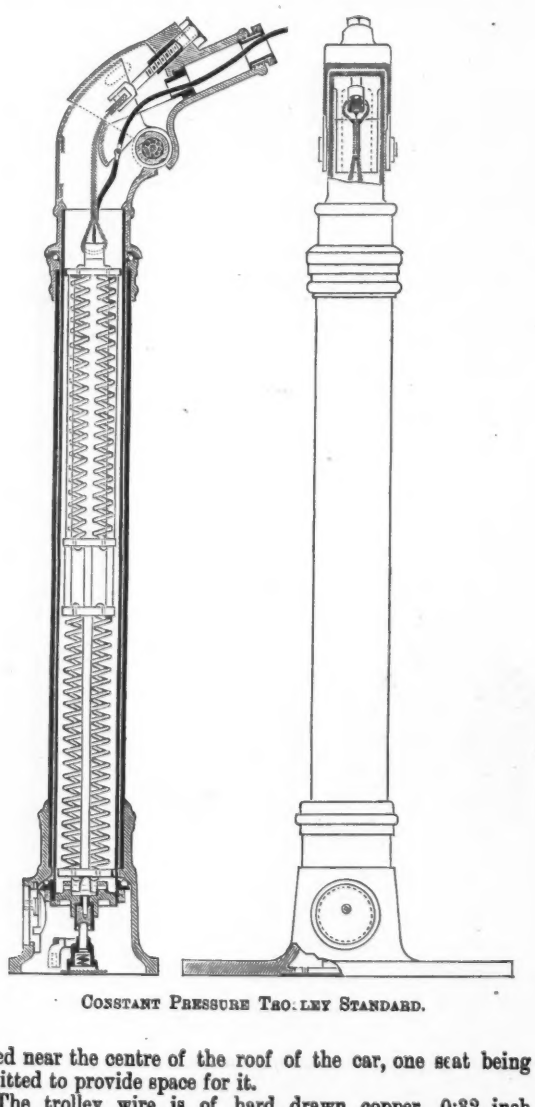
Boilers and Mechanical Stokers.

trolley on the wire over this wide range, a special trolley standard is used, the invention of Mr. Winslow. Our illustration shows that in this type the springs are concealed in the body of the standard, with great advantage on the score of appearances; the leverage of the springs is made to depend upon the slope of the trolley pole by means of a cam of suitable shape, with the result that the upward pressure is the same in all positions of the pole. A cast-iron



Harp for Bracket Arm Suspension.

"bonnet" is used to keep the standard rain-proof, and the rotating parts, as well as the pivot of the trolley pole, are mounted in ball bearings; electrical connection is maintained by means of a spring contact in the base of the standard. The whole arrangement is extremely neat and compact, and we saw it working perfectly on the occasion of our visit; it is



Constant Pressure Trolley Standard.

fixed near the centre of the roof of the car, one seat being omitted to provide space for it.

The trolley wire is of hard drawn copper, 0·32 inch diameter, and is double in most parts of the system. It is supplied by feeders laid underground in the town, but carried on the poles in the open country. There are three feeders of 0·24 square inch cross section, 300, 1,900, and 1,300 yards in length, and one feeder of 0·5 square inch, 1,200 yards long. There are no insulated return feeders, but the rail return from the old line, five miles long, is supplemented by old rails laid four in parallel, and jointed with plastic bonds.

The overhead work was carried out, and the rails laid, by Messrs. Pauling & Co., Limited, London, who contracted for the whole of the new work. The line materials, steel poles and trolley standards, were supplied by Messrs. Blackwell and Co., and the feeders were made by the British Insulated Wire Company, Limited.

There are two six-track car sheds, capable of accommodating 12 and 15 cars respectively. One of these is operated with transfer tables, but in the newer one points and crossings are in use. A well-equipped repair shop is annexed to the larger shed, where all sorts of repairs are carried out; cars are rebuilt, armatures re-wound, wheels forced on axles, and trued up by means of a Hampden car-wheel grinder. The latter is said to be the first of its kind introduced into this country. It is fixed below the floor level, so that a car can be run into position and its wheels ground true with corundum grinders with a minimum of time and labour. Amongst other machines in this shop are two screw-cutting lathes, two drilling machines, hydraulic wheel press, shaping and screwing machines, and wood-working tools, driven by a 5 and a 10-H.P. motor.

The cars were supplied by the Brush Electrical Engineering Company, Limited, and are of various sizes, all double-deck; each car weighs 5½ or 6½ tons empty, is mounted on the Peckham truck, and is fitted with two 20-H.P. Westinghouse motors. The gear is of steel, with a ratio of 4·61 to 1. The maximum running speed is 10 miles per hour, and the schedule speed 6 miles per hour. To ensure efficient service, a bonus of £1 every four months is granted to every motorman and conductor who has had no accident, and whose conduct has been satisfactory.

The chief engineer of the tramway is Mr. I. E. Winslow; the resident engineer is Mr. T. R. Whitehead, who is also manager of the tramways. To these gentlemen, and to Mr. Sutherland, who was in charge of the power station at the time of our visit, we tender our thanks for their kind help towards the preparation of this article.

NOTES.

War Notes.—At the Electro-Harmonic Society Smoking Concert held on the 26th ult., after the singing by Mr. Ivor Foster of the "Absent-Minded Beggar," the sum of 10 guineas was collected for the War Fund, which sum has been duly forwarded to the *Daily Mail*.

In response to an appeal made in the *Birmingham Daily Post* on Saturday morning, Mr. Hall-Edwards, who is going out as X ray expert to the Cape, has received from Messrs. Thomas Parker, Limited, electrical engineers, of Wolverhampton, the gift of a dynamo for electrically-lighting the operating theatre of the Imperial Yeomanry Hospital in South Africa. The dynamo has a capacity of 105 volts and 15 amperes, and will supply 16 lamps of 16 C.P. The dynamo will serve not only to illuminate the operating theatre but to furnish the current for X ray work, and will, therefore, prove a most useful gift. Offers of electrical fittings are also being made.

From the London and provincial works of the General Electric Company, Ltd., 19 employés have gone to the front, including, from London, Mr. Woolhouse, who joined the C.I.Vs., Messrs. Joyce, L. C. Holt, Bridges, Goodrich, C. Trippe, and Dennis, who have joined the Yeomanry, and two Reservists from the electric lamp works. From Manchester seven Reservists have left, and three other employés are with the Yeomanry. Messrs. Trippe and L. C. Holt, who are with the Montgomeryshire Regiment, have been put in charge of the Colt's galloping gun. The troops expect to receive orders to embark this week.

Northern Society of Electrical Engineers.—The annual dinner of this society will take place on Friday, February 16th, at the Grand Hotel, Manchester. Mr. S. Z. de Ferranti, the president of the society, will preside. Every effort is being made to ensure a thoroughly representative gathering on this occasion.

Lectures and Papers.—The first of a course of six fortnightly lectures, under the auspices of the Oxford University Extension Movement, on "Electricity," was given at Hereford last week by Mr. George Fletcher, F.G.S.

Dr. A. P. Laurie (lecturer on Chemistry and Physics at St. Mary's Hospital, London), lectured at Doncaster last week on "The Electric Current: Its Production and Use."

A few days ago Mr. A. H. Fison, D.Sc., lectured at the Portsmouth Town Hall on "Wireless Telegraphy."

Before the Greenock Association of Practical Science on 25th ult., a demonstration on "Aluminium and its Uses in Commerce" was given at Glasgow by Mr. Herbert Bubb, manager, British Aluminium Company, Greenock.

At the Institution of Engineers and Shipbuilders in Glasgow on 23rd ult., Mr. W. A. Chamen read a paper on "The Electric Wiring of Buildings," Prof. Jamieson on "The Action of Electric Tramway Currents upon the Working of Submarine Telegraph Cables and other Circuits," and Mr. William O'Brien on "A New Balanced Piston Valve and its Application to Four-crank Engines."

The Manchester Society of Junior Electrical Engineers.—A general meeting of this Society was held on Saturday evening last at the Engineering Laboratories, Whitworth Street, Manchester, when a discussion was opened by the President, Mr. W. W. H. Gee, B.Sc., on "Electrical Engineering in Switzerland." With the aid of lantern illustrations, he was able to describe the chief electrical items seen by the Institution of Electrical Engineers' deputation during their recent visit to Switzerland. A very interesting discussion on the subject followed. A presentation of books was then made to a member of the committee, Mr. S. Payne, who leaves for South Africa shortly for the benefit of his health.

Obituary.—We learn with regret of the death of Eliot Hodgkin, V.D., Major 3rd Vol. Batt. the East Surrey Regiment, who took a prominent part in the management of the Pulsometer Engineering Company, Limited, from its formation until December 8th last. We are informed that on that date he received, owing to an accident in the hunting field, a severe injury to the spine, to which, after much suffering, he succumbed on the 12th ult.

Will.—Sir Rawson William Rawson, of 68, Cornwall Gardens, K.C.M.G., C.B., Secretary at the Cape of Good Hope 1854—64, Governor of the Bahamas 1864—68, and of the Windward Islands, 1868—75, who died on November 20th last, aged 87 years, left an estate valued at £1,579 1s. 3d. gross. Sir Rawson was in his later years connected with various electrical concerns.

The Institution of Junior Engineers.—The fifteenth annual dinner of this Institution was held on January 27th at the Westminster Palace Hotel. The chair was taken by the Hon. C. A. Parsons, president, supported by Mr. T. G. Bowles, M.P., Mr. B. H. Joy (chairman), Prof. S. P. Thompson, Major Crompton, Mr. A. A. Campbell-Swinton, Mr. J. MacFarlane Gray, and a large number of members. The loyal toasts having been honoured, Mr. T. G. Bowles proceeded to propose "Our Imperial Defences," coupled with the name of Major Crompton, in a speech which was wholly unsuited to the occasion, and was calculated to damp one's spirits to the last degree. Mr. Bowles blamed the Cabinet for its conduct of the war, and of the Army and the Navy, and asserted that he "told them so" three months ago—when he was howled down! He called for a court of inquiry upon the generals to be held on the conclusion of the war, and said "brains" were wanted, not money and delicacies. Small wonder that the toast was not honoured, being apparently quite forgotten! Major Crompton was heavily handicapped by such a dismal speech, but bravely remarked that he could not disparage his future comrades; the strange conditions must be taken into account in their favour. He was to be in command of a corps of picked trained men; he was not going out to fight, but to help those who fought, and to save life with electric light and telephones. The corps would do their best, and try to do their duty; his greatest ambition was to bring all his young men back unharmed! The Major stated that in two months' time both armies would have to withdraw for want of water; but a friend pertinently asks, why should *our* army retire? We have engineers competent to quickly lay pipe lines and pumping stations to convey water to any distance, whereas our enemy cannot do this—wherein lies our gain. Prof. Thompson replied to the toast of the "Past Presidents," and congratulated the Institution on its perpetual youth and vigour; and Mr. Basil Joy, replying to the toast of "The Institution," proposed by Mr. Campbell-Swinton, stated that there were now 572 members, showing an increase of 40 in the last year. The Institution is now seeking to obtain a Charter of Incorporation. In proposing the health of "The President," who was a wrangler, Mr. Berry referred to the advantages of a mathematical training, and enunciated the following problem:—"Given the number of a policeman, and the circumference of his beat, find his *area*!" The President in his reply, referred to the difficulties our soldiers have to contend with in South Africa, and expressed his belief that the generals had done their best, and would eventually succeed. The meeting closed with an enthusiastic farewell to Major Crompton. During the evening Messrs. Chabot, King, and Chubb, contributed songs and recitations, and Mr. T. E. Gatehouse (hon. member) performed selections on the violin.

Steam Turbines.—In the course of his lecture on "Motive Power, High Speed, Steam Turbines," before the Royal Institution last Friday night, the Hon. C. A. Parsons, referred among other matters to the use of turbines for electrical purposes. He said that with the introduction of the dynamo the desirability of a high-speed engine was perceived, and the problem became to produce an ideal rotary engine. In 1884 experiments were begun for the construction of a steam turbine which was designed to run as slow, while the dynamo went as fast, as possible in order to admit of direct coupling. Special bearings were devised for keeping down the vibration, and the turbine itself, which was of 10 H.P., making 18,000 revolutions a minute, consisted of 15 successive turbine wheels, gradually increasing in size, to allow for the expansion of the steam. Defects were noticed, one being a tendency to whip in the spindle, with accompanying loss of efficiency, but it was seen that these would decrease with increase of size, and therefore efforts were made to construct bigger engines. In 1888 several turbo-alternators were supplied, of 120 H.P., non-condensing, running at 9,000 or 10,000 revolutions a minute, and taking about 35 lbs. of steam per electrical horse-power, while in 1892 the adaptation of turbines of the radial flow type to work with condensers marked an epoch as regards economy in steam power. Turbines of 2,000 H.P. were now being constructed, still bigger ones being contemplated, and a large turbo-alternator recently tested was found at full load to consume only 18·8 lbs. of steam, 10° superheated, per KW.-hour. The greater portion of Mr. Parsons' lecture was devoted to the application of the steam turbine to marine work.

The Royal Society.—Among the papers down for reading yesterday were the following:—Dr. Bottomley, F.R.S., and Dr. Beattie, "Thermal Radiation in Absolute Measure." Dr. McLennan, "Electrical Conductivity in Gases Traversed by Cathode Rays."

Personal.—Mr. E. S. Saunders has been appointed departmental engineer at the Bradford electricity works in succession to Mr. A. H. Roe, who has taken the position of borough electrical engineer to Bury St. Edmunds. Mr. Saunders previously acted as Mr. Roe's assistant.

French Cable Schemes.—The *Morning Post* correspondent at Paris says that the telegraph cables proposed by the French Government in its Bill are, first, a line between Oran, Tangier, Teneriffe, and St. Louis; secondly, a line from Hué to a point north of Hong Kong; thirdly, a line from Tamatave to Reunion; fourthly, submarine cables between French Benin and the French Congo; fifthly, the extension and improvement of the landlines in West Africa, the expense not to exceed 1,000,000 francs. The total expenditure will be about 150,000,000 francs.

Rucker v. London Electric Supply Corporation, Limited.—Yesterday (Thursday) Mr. Bousfield concluded his speech for the plaintiff, and Mr. Justice Farwell reserved judgment.

LONDON COUNTY COUNCIL.

The Finance Committee at a meeting of the Council on Tuesday reported that the Islington Vestry had applied for sanction to borrow £56,261 for electric lighting purposes. It was decided to limit the consent to £38,000 on account of the application, as further information was required from the Vestry before the Finance Committee could deal with the balance. A second request from the same authority for sanction to borrow £13,200 was granted to the extent of £10,000, further details of the proposed expenditure being asked for also in this instance.

PROVISIONAL ORDERS.

The Highways Committee submitted a long report in regard to the following six applications made for provisional orders this session:—A. Limehouse District Board; B. Vestry of Mile End; C. Vestry of St. George-in-the-East; D. County of London and Brush Company; E. South London Electric Supply Corporation; and F. the Marylebone Electric Supply Corporation. On the question of price the Committee stated that they had come to the conclusion that the maximum charge under all the orders should be 5d. per unit, and that the system of supply should be by continuous current. Suggestions for amendments in these respects were made to the Board in the case of the orders applied for last year, but the Board of Trade did not adopt them. As, however, the Committee attached importance to them, they thought that the Board should be asked to again give them consideration, and the Council adopted recommendations to this effect.

The Highways Committee mentioned that in the orders A, B, E, and F, the clauses of the Electric Lighting Clauses Act, 1899, are incorporated. That Act provides that the provisions contained in the schedule shall be incorporated with, and form part of, every provisional order made by the Board of Trade under the Electric Lighting Acts; but the Act does not apply to the county of London *except* so far as any of the provisions are incorporated with any provisional order relative to areas in that county. The Act of 1899 was apparently in the first instance not intended to apply to London, and it does not confer upon the Council the powers and duties devolving upon it under the orders hitherto granted as to London areas. This point has not arisen on any previous orders relative to London, as the Act was only passed last year; and it appears desirable that it should be suggested to the Board of Trade that the orders should be so amended as to make them conform with those previously granted in respect of London areas. This appears to be the most expedient course to be taken, as it would probably be somewhat difficult to avoid complication if the clauses referred to above were incorporated in the order, and further clauses were to be added for the purpose of conferring upon the Council powers and duties which have been imposed upon it under the orders hitherto granted with regard to areas in London. If the suggestion were adopted, each order would then be complete in itself, and, without reference to any Acts of Parliament other than the Electric Lighting Acts of 1882 and 1888, would clearly specify the powers and duties devolving upon the undertakers, the Council, and other authorities or persons concerned.

The Committee recommended, and it was decided to inform the Board of Trade that in the opinion of the Council it is undesirable that the clauses of the Electric Lighting Clauses Act, 1899, should be incorporated in provisional orders relative to London areas; and that the Board be asked to so amend the orders relative to (*a*) Limehouse; (*b*) Mile End Old Town; (*c*) Lambeth; and (*d*) Marylebone, now being applied for, as that each order may be in the same form as those previously granted as regards London areas, and may be complete in itself.

THE CAMBERWELL ORDER, 1896.—As to this order, the Committee stated that it contains "a clause providing that at any time during the first 21 years after the granting of the order, the local authority may purchase the undertaking upon payment of 1½ times the capital outlay of the undertakers, plus the sum necessary to make the dividends up to an average of 5 per cent. from the commencement, and after the 21st year upon the same terms, but without the condition as to 5 per cent. dividend, or, as an alternative, on payment of the 'then value,' plus an allowance for goodwill. We think it advisable that this clause, which was agreed upon between the Vestry and the undertakers, should be inserted in the orders granted to companies. We are advised that on this particular point the Council has no *locus standi*, and we have therefore directed that the attention of the various local authorities concerned shall be called to it in order that they may, should they consider it expedient in their own interests, make representations to the Board of Trade with a view to the insertion of the clause in the orders relative to their respective districts. We have also suggested to the local authorities concerned that they should ask that the option of purchase may be exercised at the end of every period of *seven*, instead of *ten*, years after the expiration of the first statutory period of 42 years from the date fixed by the order."

THE ST. GEORGE-IN-THE-EAST ORDER.—This order is applied for by the Vestry, and is in respect of the whole of the parish. In this connection the Highways Committee stated:—The County of London and Brush Provincial Electric Lighting Company has already obtained powers under the County of London (East) Order of 1897 for the supply of electrical energy in respect of this area. The order is practically in model form, and continuous current is provided for. In the clause as to maximum price a proviso is inserted empowering the Board of Trade, on representation being made by the Council or the undertakers, that the prices or methods of charge should be altered, to make an order with reference thereunto. This proviso has not been inserted in orders granted to local authorities, but has been in those granted to companies, and we see no objection, but rather an advantage, in the proviso being inserted. The order also contains a clause in the usual form, enabling the powers granted under the order to be transferred. In view of the exceptional position occupied by one company to which an order granted to a Vestry had been transferred, inasmuch as the company has, under the order, only to serve notices and plans of works, and the Council has no power, as in the case of orders granted to companies direct, of approval or disapproval of the works, the Board of Trade has in previous cases struck out the provision authorising the transfer of the undertaking. We think, therefore, that it should be suggested to the Board that the same course should be adopted as regards the order applied for this session by the Vestry of St. George-in-the-East.

On the recommendation of the Committee, the Council resolved to ask the Board of Trade to omit the clause authorising the transfer of the powers.

THE BATTERSEA ORDER.—The Committee stated they were in communication with the Battersea Vestry on the subject of the County of London and Brush Company's application, and that they proposed to report further at a later date.

THE LAMBETH ORDER.—It was decided to ask the Board of Trade to so amend the order applied for by the South London Electric Supply Corporation as to bring it into conformity with orders previously granted to companies; in respect of metropolitan areas, to make in such order the amendments suggested by the Highways Committee, and to insert a provision to place the company under the same obligations as though the order had in the first instance been issued to the company, and not to the Vestry.

THE MARYLEBONE ORDER.—It was resolved to ask the Board to so amend the Marylebone Electric Supply Company's order as to make it conform with those previously granted to London electric lighting companies. The Highways Committee considered that should the Vestry eventually decide not to enter into arrangements for the purchase of the Marylebone portion of the Metropolitan Company's undertaking it would be rather an advantage for a competing service to be established by another company.

THE LIMEHOUSE AND MILE END ORDERS.—The Council decided to ask the Board to amend these orders so as to make them conform to those previously granted to other London local authorities.

OUR POSITION AS ENGINEERS.*

(*Concluded from page* 159.)

So far, gentlemen, I have dealt with the matter on somewhat general lines. I now desire to draw your attention to what is taking place at the present time. As you are all aware, there have been orders placed in America within the past few months for a number of locomotives, some of which have been delivered and some are now in course of delivery. We are all aware that the reason ascribed for these orders being placed in America was, that it was impossible to obtain deliveries within anything like reasonable time from home manufacturers. I suppose we must accept this as true, but, I ask, is it creditable to us as a wide-awake business people that we have not sufficient energy, forethought, and adaptability to increase our facilities to keep pace with our requirements. The fact that America can supply her own wants, together with a large foreign trade, including our colonies, and still have left a sufficient surplus of producing power to supply a portion of our wants, proves the case against us. I think no one will be bold enough to assert that there is not sufficient capital in England to extend and increase the number of works for the manufacture of this particular branch of engineering. If there is the capital, is there the energy and enterprise to use it? I know that this question may be met by the answer, that it would be all very well if this present activity could be guaranteed to continue. What are we to do about the locked-up capital in the years of depression in trade? My answer to this argument is that exactly the same laws of fluctuation prevail in America, and yet it does not prevent the Americans from rising to the demands made upon them.

It may be said that at home many of the railway companies manufacture their own engines, and therefore there is not sufficient scope to warrant private enterprise in fixing capital in this particular branch of business. I am by no means prepared to accept this as a sufficient answer. I believe that with greater energy on the part of private enterprise, the market for supplying locomotives to our own railways would have been a much larger one than it is at the present time, and that the railway companies were in a large measure compelled to make themselves into producers, in consequence of the lack of facilities for obtaining their locomotives, &c., from those whose legitimate business it is to supply them. Private enterprise should, and I feel sure can, produce and sell, with a reasonable profit, at a less price than railway companies can build their own engines. Sentiment may have had some influence, but I think railway companies are managed on lines with which sentiment has little consideration, and that given equal facilities and advantages, they would quite as soon purchase engines as make them. Even should exception be taken to this latter proposition, I do not see that this materially alters the original proposition, as many of the American railway companies also build their own engines, and I have no doubt that they are also compelled to obtain engines from outside sources to meet their immediate and pressing requirements, but we never hear of them coming to England for engines at their time of special demand.

There is another branch of engineering which has been and now is suffering from an invasion of the American. I refer to the building of stationary engines for electrical installations, both for lighting and traction. Is it because the Americans can build a better or more suitable engine for the purpose, or can they supply an equally good engine at a lower price? I am aware that some orders were placed there during the strike period, but there are cases where orders have been placed in America since that time, and which I am sure could and should have been executed in this country. We all remember what has taken place very recently at Glasgow, that out of a requirement of four large engines for tramway traction purposes, the order for two of these engines has been placed in this country and the order for two has gone to America. Could not the construction of the four engines have been undertaken by English firms, and if not, why not? Each may answer this question in his own way, but to my mind this placing even part of the order in America points to a lack of energy and enterprise on our part, and clearly proves that we have not placed ourselves in a position to deal with this or any other work of a like character of whatever magnitude. I am afraid we have got into a much too easy-going, self-satisfied style that we have become too well off, and, like Jeshurun of old, we have waxed fat. It appears to me to be a very humiliating position for us as engineers, that the foregoing orders for something like 100 locomotives and for at least 25 sets of large stationary engines (one firm alone having supplied this number in the last three years) should, from any cause whatever, be placed outside our own land with all its boasted skill and constructive power. These orders will, in the aggregate, amount to about half a million of money, and I see no sufficient excuse for them being executed abroad, except our apathy, want of energy and inadaptability.

* **Inaugural address to the Manchester Association of Engineers by the President, Mr. Henry Hodgson, delivered Saturday, January 13th, 1900.**

The foregoing does not even exhaust our delinquencies on this head. Russia at one time was our best customer for steam engines (stationary and locomotive), but now the orders for this class of work are few and far between, as far as we are concerned. What is the explanation? Do they manufacture these for themselves now? Yes, to some extent, but by far the largest number of orders for the stationary engines required in Russia go to one firm in Switzerland. I say all honour and credit are due to the firm to which these orders go, for their enterprise, or whatever other cause may have led to this result. From what I can learn this firm not only secures the orders, but they secure them at better prices than English firms quote, when they have the opportunity of quoting. The specimens of engine work supplied by this firm, which I have had the opportunity of examining, leaves nothing to be desired on the score of quality, but surely engineering firms in England can do as good work, and obtain as good results, as any engineering firms the world through. Then why have we let this market slip through our fingers? I can give no other reason than what I have before given, viz., apathy, lack of energy, and inadaptability.

Our machine tool makers will have to be up and doing if they wish to hold the excellent position they have hitherto occupied. Within the last few years there has been a movement in the right direction by those who are responsible for this class of work, and the automatic labour saving tools, which are so much in evidence on the other side of the Atlantic, are being manufactured hear in constantly increasing numbers, and greater care and thought are being given to the production of tools, which will enable work to be produced cheaper and better than formerly. From what I have seen of American tools for doing heavy and medium-sized work, I do think that our machine tool makers are far ahead of our competitors, and, providing they will only be content to keep awake, they have not much to fear.

There will always be some men who must travel on different lines than the ordinary run of mankind, and who, from fear of being thought antiquated, will purchase the latest novelty, without, in my opinion, giving sufficient consideration to its economical advantages. I am glad that there are such men, and it may be that they are only living a little before their time. They certainly answer the useful purpose of acting as a spur to the slower and perhaps soberer portion of mankind.

A few months ago I had the opportunity of inspecting some American lathes, which, as specimens of workmanship, were very good; as specimens of suitability for the work they were expected to do, they were in my opinion very bad. They had a goodly number of appliances never seen on an English built lathe, and which will, I believe, be either taken off in a few months, or perhaps left on but never used. The non-use of these appliances will probably be set down to the stupidity or obstinacy of the workman. In these particular machines I am quite certain that if a fair and honest trial could be made between them and English made lathes of the same rated sizes, both better and more work would be done on the English machines, and yet these lathes cost quite 50 per cent. more than equal sized machines of English make, by first-class firms.

There is one branch of engineering in which, up to the present, competition has not invaded our shores. I allude to shipbuilding and marine engine building; but even in this particular branch of engineering our two competitors (America and Germany) are now in a position to supply almost without exception their own requirements, and are, especially the latter, supplying some other countries with a large portion of their needs in this line. I ascribe this more particularly to political influences than to those of an economical character. Our supremacy, even in this, which we may term our national branch of engineering, is being successfully assailed, and we shall have to take greater heed to our steps than we have done lately if we are to maintain our supremacy. We have allowed Germany to make herself possessor of the blue ribbon in the races across the Atlantic; we have also allowed her to hold for a time the honour of having built the largest steamer the world has yet seen, and I do not think it will be long before she again takes the position.

In the manufacture of textile machinery I believe we are, up to the present, unassailable. In the attempts that other countries have made to dispense with our services in this particular branch of engineering, their work comes immeasurably behind ours, and it is only through political jealousy and national prejudice that our competitors in this branch of business exist at all.

There are other businesses of an engineering character which might be dealt with, but I have touched on sufficient to create some interest in your minds on a subject of such vital importance to the welfare of this country in general, and of engineers in particular. The subject is one that demands the most careful consideration of every one, not engineers alone, but every one who may have the welfare of this country at heart, and unless we are prepared to take prompt and, I fear, drastic measures, we shall have to bewail a still further falling away from our position as a foremost producer.

When the present abnormal demand is over and the world settles down to a scramble for work, then will come the testing time, the competition will not be confined amongst ourselves, and, unless we take steps to place ourselves in a better position to meet the outsider, I am afraid we shall in the end come off very badly.

In the foregoing I have dealt with our position as engineers as I see it; others may view it from different points, and may attach much less significance and weight to the position than I do, but I venture to think that the more consideration each gives to the matter, the more weight will they be inclined to attach to what I believe to be an extremely grave question. At any rate, in thinking over the subject in the course of preparing this address, it has impressed itself upon my mind, as second only in gravity with the war upon which we are at present engaged, and will probably be even more far-reaching in its results, unless vigorous steps are taken to amend our system of working.

CITY NOTES.

Eastern Extension Telegraph Company, Limited.

The fifty-fifth half-yearly meeting of the shareholders of this company was held on Thursday at Winchester House, Old Broad Street, the Marquis of Tweeddale presiding.

In proposing the adoption of the report, the Chairman said that the gross revenue for the half-year had amounted to £474,950, being an increase of £30,939 over the corresponding period of 1898. The expenses had amounted to £121,630, an increase of £354. The expenses attending repairs and renewals to cables showed a decrease of £8,620 which was to a large extent due to the extra credit received from the South African Company for the hire of one of the company's ships to replace their ss. *Duplex* while laid up in harbour in London undergoing repair and general overhaul. The principal increases in the revenue had been derived from the traffic with the Philippines, Australia, and the Cape, but there was no very important development of any particular traffic. During the present crisis in South Africa, some exceptional delay in the transmission of Press messages had occurred, but that delay had been caused by circumstances quite beyond their control. It was easy to understand the irritation to which those delays gave rise, anxious as everyone was to receive news of our gallant soldiers in South Africa, more especially when they considered the great expense incurred and the enterprise shown by the Press in supplying the country with the latest intelligence. In some cases, owing to the absence of a full knowledge of the surrounding circumstances, it had led, perhaps not unnaturally, to some undeserved complaints against this company. The delay had arisen from several causes, such as the action taken by the Press censors appointed by the Government, interruptions of one or other of their routes by the uncontrollable forces of Nature, and the excessive work thrown upon the Government landlines in South Africa. Notwithstanding the exceptional conditions under which they had been working, it was a great satisfaction to be able to say that Government messages had in no case been unduly delayed, and the rapidity in the exchange of messages between the actual field of battle and the War Office had been highly praiseworthy to all concerned. Their staff, who had at all times in the past cheerfully responded to any pressure of work, had during the present crisis exerted themselves to the utmost of their power. They heard last night from South Africa that all Press telegrams were now being censored at Cape Town only. Consequently such messages must be transmitted by the West Coast route. They had asked for a reconsideration of that order, but meanwhile the company must not be blamed for the serious delay which must necessarily occur. Having given a brief *résumé* of the history of the telegraph connection with South Africa, the chairman said that in the ordinary course they had found it sufficient to have a repairing ship stationed on each coast, but realising the importance of maintaining telegraphic communication with South Africa during the war, the precaution was taken of moving forward additional ships, in order to effect with greater dispatch any repairs which might be necessary. By those means the telegraphic communication with South Africa had so far been secured during the present crisis, and the periods of interruption have been to a great extent minimised. Before leaving the subject of South Africa, he thought it might be as well to correct any impression that they were deriving enormous receipts from the effect of the war. In the first place, let it not be forgotten that the tariff was reduced 20 per cent. from September 1st last; and in the second place, it must be remembered that the lines had been very greatly occupied by the Government traffic at half rates and by Press traffic at quarter rates, although in several instances the Press have paid full rates in order to have their telegrams sent as ordinary messages. The carrying capacity of all cables was limited, and it had been found necessary to restrict the number of words from each correspondent. When all those factors, together with the additional maintenance expenses and the extra cost of working the new line which was being laid to the Cape, were taken into account, they might find that the additional traffic carried during the war would be barely sufficient to recoup them for the loss which they might sustain in the future by the disturbance of commercial business. The directors, with the object of providing additional security to the submarine telegraphic communication with this country and South Africa, decided to lay down a third series of cables, connecting with their system at the same time the strategically important islands of Ascension and St. Helena. For a project of such magnitude, involving as it did an expenditure of approaching 3 millions of capital, without tapping any fresh source of traffic, involving most important reductions of tariff, and complicated by the sympathy in certain quarters for a connection to Australia by a State-owned cable across the Pacific Ocean, it was not so difficult to realise why the negotiations had been of so protracted a nature. Notwithstanding the delay in the Australian negotiations, however, they still considered it advisable to expedite to the utmost of their power the South African connection; and they ultimately arrived at an understanding with the Postmaster-General of Cape Colony for landing rights at Cape Town, and with the English and Portuguese Governments for similar rights at Ascension, St. Helena, and St. Vincent respectively; and the tariff was immediately reduced from 5s. to 4s. per word, with a proposed arrangement for a possible reduction to 2s. 6d. per word on the sliding scale principle as the traffic responded to the reductions. Although those negotiations were only concluded in August last, they hoped to have the connection completed with Cape Town to St. Vincent before the end of next month; and with the existing duplicate cables of their allies, the Western Telegraph Company, and the triplicate cables of this

company, a third route would then be available to South Africa. In conjunction with the Eastern Company, they were now proceeding with the remaining negotiations, which included an immediate reduction in the Australian tariff, and possible ultimate reductions to 2s. 6d. per word on a similar sliding scale to that suggested for the South African tariff. That arrangement was, however, based upon the reasonable condition that the Eastern Extension Company were granted the same freedom of dealing direct with their customers in Australia as they were at present enjoying in this country and elsewhere, and they looked forward with confidence to a satisfactory solution before long. In conclusion, he referred at some length to a proposal to alter the trust deeds of the staff pension and superannuation funds so as to admit of the retiring age being reduced from 60 to 55.

Mr. J. Denison Pender seconded the motion, and the report was adopted.

A formal resolution was also carried authorising the directors to increase the company's contribution to the staff pension fund from January 1st, 1900, to 4 per cent., and provide a sum sufficient to enable the pensions which have already been purchased to December 31st, 1899, to be paid at the age of 55 instead of 60 years; also to guarantee the loss (if any) to the staff superannuation fund which might occur by reason of the reduction of the age limit to 55 years.

Automatic Telephone Company.

The annual general meeting of the above company was held at the Cannon Street Hotel on Thursday morning last week, Mr. H. G. Sworn (chairman), presiding.

The Chairman said he would point out that the auditors, Messrs. W. H. Pannell & Co., did not vouch for a certain part of the accounts—the legal expenses (£135). Mr. Pannell had not been invited to the meeting.

Mr. Parker raised the question of the 1898 accounts, which he said were not passed at the last meeting. The Court declared that the last meeting was null and void.

This raised some discussion between Mr. Spiers (the company's solicitor) as to the exact terms of the judgment of the Court, and it was agreed to treat it as a matter on which lawyers differed.

The Chairman then proceeded to explain certain payments to solicitors, and said the board could vouch that the cheques had been paid.

Mr. White said he formally protested against the accounts being passed until they had received the 1898 accounts.

The Chairman then moved, and Mr. Margowski seconded, the adoption of the report.

Mr. Cooper asked what was meant by new patents being taken out, and also would like to know if the company was working at all.

The Chairman: No; it is developing its patents. It is taking out the patents and preparing the roads for working.

Mr. Cooper severely criticised the figures in the balance-sheet. He wanted to know why, if Mr. Margowski owed the company £100, he was not made to pay, and why the consulting engineer should be paid £362 16s. 10d. for salary and travelling expenses if nothing had been done.

Mr. Alexander said he attended every meeting of the board and the accounts were never placed before him, although he did not suggest that the payments had not been made.

Mr. Cooper said it seemed to him that the question before them was whether the company had not better be wound up.

Mr. Parker said that so long as Mr. Margowski controlled the shares the shares were absolutely worthless.

Mr. Margowski repudiated the suggestion that he controlled the shares of the company, and entered into a long statement as to the disagreements which had taken place between the company and the inventing engineer. He said they were at loggerheads with their consulting engineer, but now Mr. Seligman Lui had accepted fully paid shares in consideration of his inventions. He (the speaker) claimed that he had done his best for the company, and that had it not been for him the company would not have been in possession of a single patent. If the shareholders supported him, he was prepared to carry the company to a commercial success. He would take no fee whatever, but look only to future prospects.

Mr. Gibbs (another director), said he had seen Mr. Seligman Lui, and tried to put an end to the friction. He had received a letter the previous day, in which Mr. Seligman Lui said he agreed that all the contracts between Mr. Margowski and the company, and himself and the company, should be annulled, and a fresh contract entered into. The conditions he laid down were that all his legal expenses should be paid, and his salary for 1898, and also that there should be no recurrence of the acts which had led him to take action against the company.

A Shareholder asked what Mr. Seligman Lui was going to do for the company. Was Mr. Lui confident that the invention was a commercial success?

Mr. Gibbs: Undoubtedly.

The Shareholder: Then we ought to give him what he wants.

The Chairman said the letter had not been before the board.

Mr. White said that Mr. Seligman Lui wanted the company to be in the hands of the shareholders and not in the hands of Mr. Margowski.

The Solicitor said it was impossible to properly carry on the company with two parties on the board, and since they had been on the board he had made proposals to the leader of the opposition which he thought would be agreeable.

Mr. Parker said he had been asked to join the board but had declined to do so so long as Mr. Margowski controlled the voting power of the board. Since he had been in the room he had been approached by the solicitor who suggested that a new board might be constituted agreeable both to Mr. Margowski and to the shareholders. It was suggested that Mr. Alexander should retire, and that he himself and Mr. Cooper should be appointed new directors.

Resolutions to carry out the suggestions of Mr. Parker were carried, and Mr. Parker was elected chairman of the board. The meeting was then adjourned to enable the new board to go into the accounts.

Liverpool Overhead Railway Company.

The report of the directors to be submitted at the half-yearly general meeting of shareholders, to be held at the Law Association Rooms, 14, Cook Street, Liverpool, on Tuesday, February 13th, reads:—"In presenting the half-yearly statement of capital and revenue accounts to December 31st, 1899, the directors have to report that the gross revenue receipts amount to £42,928 11s. 9d., and the working expenses to £25,007 5s. 5d.

"The number of passengers carried during the last two years is as follows:—

	Half-year ending June 30th, 1898.	Half-year ending Dec. 31st, 1898.	Half-year ending June 30th, 1899.	Half-year ending Dec. 31st, 1899.
First class	637,547	663,177	594,669	676,768
Second class	2,686,651	2,962,827	2,445,572	2,941,392
Workmen (special return tickets)	1,148,743	1,268,917	1,435,038	1,596,797
Total ..	4,472,941	4,894,921	4,475,279	5,214,957

"There has been an increase in the number of passengers carried of 320,036, and in receipts of £1,940. The works of the Waterloo and Great Crosby Tramways are proceeding, and it is hoped they will be opened for traffic during the half-year. The directors are promoting a Bill in Parliament for a short extension northwards, to join the Seaforth station of the Lancashire and Yorkshire Railway, and southwards for a short line beyond the Herculaneum station, and for widening the line at Pierhead station.

Revenue Account.

	£	s.	d.
Receipts from passenger traffic amount to	42,011	7	8
Miscellaneous receipts and interest	917	4	1
	42,928	11	9
Less working expenses	25,007	5	5
	17,921	6	4
Deduct interest on mortgage debentures	3,400	0	0
	14,521	6	4
Add balance brought forward, June 30th, 1899	4,320	8	3
Leaving available for dividend	18,841	14	7

"Out of this balance the directors recommend the declaration of dividends at the following rates (less income-tax), payable on and after February 16th next:—5 per cent. per annum on preference shares, £3,000; 5 per cent. per annum on ordinary shares, £11,250; leaving a balance of £4,591 14s. 7d. to be carried forward to next half-year. The directors retiring by rotation at this meeting are Mr. Richard Hobson and Mr. James Barrow, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. George Nicholson, who is also eligible for re-election."

Anglo-American Telegraph Company, Limited.

The directors' report to be presented to the ordinary general meeting at Winchester House to-day, at 2 o'clock p.m., reads:—

The total receipts from July 1st to December 31st, 1899, including the balance of £24,701 8s. 2d., brought forward from the last account, amounted to £232,776 8s. 5d. The traffic receipts show an increase of £6,798 as compared with the half-year ended December 31st, 1898. The total expenses of the half-year, including the repair of cables, &c., as shown by the revenue account, amounted to £67,171 5s. 6d., being an increase of £3,766 7s. over the corresponding period of 1898. The directors, under the powers conferred upon them by the Articles of Association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £153,605 2s. 11d. Interim quarterly dividends of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, were paid on November 1st last, absorbing £52,500, leaving a balance of £101,105 2s. 11d., out of which the directors recommend the proprietors to declare final dividends of £1 8s. 6d. per cent. on the ordinary stock, £1 10s. per cent. on the preferred stock, and £1 7s. per cent. on the deferred stock, amounting to £99,750, making a total distribution for the year ended December 31st, 1899, of £3 18s. 6d. per cent. on the ordinary stock, £6 per cent. on the preferred stock, and £1 7s. per cent. on the deferred stock. The balance of £1,355 2s. 11d. will be carried forward to the next account. In accordance with the Articles of Association, two directors of the company, Mr. S. Barber and Mr. R. H. Benson, retire at this meeting, and, being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. John Gane, F.C.A., the auditors, retire, and offer themselves for re-election.

The Direct United States Cable Company.

The half-yearly meeting of the shareholders of this company was held on Tuesday at Winchester House, Mr. E. M. Underdown, Q.C., presiding.

The CHAIRMAN, in proposing the adoption of the report, said the revenue for the six months to December 31st, after deducting outpayments, amounted to £56,800. The working and other expenses, excluding the cost of repairs to cables, had absorbed £20,416, leaving a balance of £36,384 as net profit. With the £3,176 brought forward from the previous half-year there was a total balance of £39,560, which had been appropriated as follows:—Interim dividend of 3s. per share up to September, £9,106 10s.; interim dividend 3s. per share to December 31st, £9,106 10s.; set aside to reserve fund, £15,000; carried forward, £6,347. It was satisfactory to be able to say that the revenue had continued to improve, and showed the not unsatisfactory increase of £2,434 as compared with that for the corresponding period of 1898. The expenses on the other hand showed a reduction of £1,205, and that was owing chiefly to the less outlay upon the maintenance and renewal of instruments, some special expenditure having been incurred under that head the previous half-year. Beyond that there was a saving of £249 in London salaries. With regard to the cable repairs they had cost only £1,989 which had, as usual, been charged to the reserve fund. On the other hand, that fund had benefited by £6,317, interest on investments, raising the balance of the fund to £401,693. The investments had been increased during the year by £14,319, and they now stood at a total cost of £380,601, but their present market value was about £410,600, or £30,000 above their cost, and that notwithstanding the great fall in the market price of even first-class securities. Their cable was working very satisfactorily with duplex, and that had been very useful in regard to their contributions to the pool. One shareholder had written suggesting that the board might have paid a larger dividend and carried less to reserve, but the board were of opinion that they must be very careful in keeping up that fund. Steps were being taken by other nations to establish telegraphic communication across the Atlantic, and shortly a cable would be laid between Germany and the Azores, and from the Azores to the United States. They could not say anything about that, but they did object to this country being made a stepping stone to these works to the prejudice of British interests. They had put those matters strongly and forcibly before the Government, and he was glad to say that, as far as they could judge, they had thoroughly entered into the spirit in which the representations had been made, and he thought they would do all they could to protect British interests. With regard also to the proposed all-British cable, the Government, he was glad so say, had shown a strong disposition to protect the interests of that and the allied companies.

Sir JAMES PENDER, Bart., M.P., formally seconded the resolution, and the report was adopted.

Douglas Southern Electric Tramways Company.

In their fourth annual report for year the ending October 31st, 1899, the directors say:—

The company's season consisted of a period of 133 days, during which the daily service was most efficiently maintained. The mileage run amounted to 87,593; the total number of passengers 100,769; and the gross traffic receipts yielded £4,444 5s. 5d. The following table gives details of the days and mileage run, the passengers carried, and the traffic receipts:—

Days.	Mileage.	Month.	Passengers.	Traffic Receipts.
				£ s. d.
1	179	March	127	4 7 0
4	859	April	592	24 13 11
11	3,181	May	4,567	193 17 9
30	6,804	June	6,979	273 7 3
31	8,555	July	21,987	941 12 11
31	10,229	August	52,454	2,326 12 6
25	7,786	September	15,473	676 17 1
			Contracts	2 17 0
133	87,593	—	100,769	£4,444 5 5

From the gross traffic receipts must be deducted £740 4s. 7d. tolls payable to the Douglas Head Marine Drive, Limited, leaving net passenger receipts £3,704 0s. 10d., to which must be added £15 14s. 6d. sundry receipts, making a total of £3,719 15s. 4d., against £3,457 14s., the net receipts of last season. No accident to life, limb, or rolling stock occurred during the season. The cold, wet, and uncertain weather during Easter, Whit-Week, and the earlier portion of the season caused a great diminution of traffic. During an exceptionally heavy gale at the beginning of January our car shed suffered severely, and caused damage which cost nearly £100 to repair. The line, rolling stock, engines, &c., have been kept in thorough repair, and all debts against the company have been liquidated out of revenue. The profit for the season's working is £1,455 4s. 3d., which, added to the profit balance brought down from the last balance-sheet, gives a disposable balance of £1,806 3s. 10d., and your directors recommend that a dividend of 6 per cent. per annum be declared on the 7 per cent. preference shares, and the balance, £271 16s. 3d., be carried forward.

At the meeting held at Manchester last week Mr. THOMAS J. HUTCHINSON, the chairman of the company, said that the past year had shown an improvement. It was very fortunate that they had been able to run such a line, with its many peculiarities, without any accidents. The report was adopted, and a dividend of 6 per cent. declared. Mr. Hutchinson was re-elected a director, on the proposition of Mr. Davenport, who said it was quite probable that an electric line would be laid from the bridge at Douglas to the top of the Head.

Waterloo and City Railway Company.

THE report for the half-year ended December 31st states that the capital account shows a total outlay of £573,656. The further estimated expenditure of £40,000 is amply provided for by the capital powers of the company. The gross receipts of the line, less Government duty, amounted to £13,349. From this amount the London and South-Western Company have retained £4,824 in respect of working expenses, leaving the sum of £8,525 payable by them, in order to provide, under the agreement of March, 1894, for a dividend at the rate of 3 per cent. per annum on the company's ordinary and borrowed capital. The number of passengers carried during the past six months was 1,769,731, exclusive of season ticket holders. On January 8th three additional entrances were opened to the City station in connection with the public subways, which are being constructed at the Mansion House by the Central London Railway at the joint expense of the two companies, and when the whole of the subways are completed, there will be two other entrances at the Royal Exchange.

City and South London Railway Company.

THE directors' report for the half-year ending December 31st, 1899, to be submitted to the meeting at Winchester House on Monday, February 5th, at 12 o'clock noon, reads:—

"The receipts from all sources for the past half-year have amounted to £27,506 1s. 3d., and the cost of working has been £15,968 4s. 6d., leaving a profit of £11,537 16s. 9d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £15,538 4s. 8d. After making provision for the debenture stock interest, a balance remains available for dividend of £11,429 19s. 6d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1½ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,267 9s. 6d., to be carried forward to the next account. Your directors regret the diminution in the dividend, arising from the increased cost of materials, and from the fact that the ordinary stock, ranking for dividend, has been increased by £225,000, expended on lines not yet open for traffic. The following table shows the number of passengers, exclusive of season ticket holders, carried since the opening of the railway in each half-year:—

Half-year.	Number of passengers (exclusive of season ticket holders).	Receipts (including season tickets).
		£ s. d.
Ended December 31st, 1890 (11 days)	165,000	1,568 3 9
„ June 30th, 1891	2,412,343	19,403 6 9
„ December 31st, 1891	2,749,055	19,798 16 6
„ June 30th, 1892	2,813,182	20,931 4 2
„ December 31st, 1892	3,117,602	22,002 17 5
„ June 30th, 1893	3,146,656	22,458 6 9
„ December 31st, 1893	3,090,351	22,067 14 10
„ June 30th, 1894	3,383,154	23,564 10 6
„ December, 1894	3,275,649	23,540 12 4
„ June 30th, 1895	3,113,199	23,711 5 8
„ December 31st, 1895	3,172,438	23,760 8 7
„ June 30th, 1896	3,[illegible]9[illegible],672	24,021 13 0
„ December 31st, 1896	3,86[illegible],480	25,456 6 9
„ June 30th, 1887	3,457,810	26,403 3 6
„ December 31st, 1897	3,337,861	25,47[illegible] 12 10
„ June 30th, 1898	3,478,977	26,356 16 4
„ December 31st, 1898	3,462,814	26,319 14 10
„ June 30th, 1899	3,540,098	26,749 3 0
„ December 31st, 1899	3,412,942	26,197 14 10
Total since the opening of the line ..	57,703,263	£429,804 7 4

"*Moorgate Street Extension.*—Your directors regret that owing to the delay on the part of the several contractors it was found impossible to open the line at the date anticipated in the last report. Every possible pressure has been put upon the contractors, and the works are now so far completed that it is hoped the sanction of the Board of Trade for the opening for public traffic will be obtained within the next two or three weeks. The delay has been a source of great disappointment, as the capital expended on the construction and equipment of the extension has consequently been unproductive in place of earning an adequate return.

"*Clapham Extension.*—The works on this extension are rapidly approaching completion; the surface stations are well advanced, and there is every prospect of its being ready for public traffic within the next three months.

"*Islington Extension.*—The sites for the stations on this extension have been acquired and are in the hands of the contractors. Good progress has been made with the tunnelling. 579 yards on the up line and 550 yards on the down line have been driven.

"The subway at London Bridge to connect this company's station at the corner of Denman Street with that of the London Brighton and South Coast Railway will be commenced as soon as some preliminary boring operations have been completed. Of the 10 locomotives referred to in the last report as under contract, eight have been delivered and are giving satisfaction.

"*Generating Station.*—The principal works necessary for running the trains to Moorgate Street are now completed, and the further power required for the extension to Clapham is expected to be ready early in March. A large new carriage shed is in course of erection.

"*Parliamentary.*—The Bill will be submitted for approval at the conclusion of the ordinary general meeting, is to obtain the sanction of Parliament to substitute a tunnel of 30 feet in diameter, for two of 21½ feet at the station at the Islington terminus, whereby greater convenience will result in the working of the traffic and a saving in the cost of construction.

"Negotiations are in progress with the Great Northern and City Railway Company for the construction of a joint station at the corner of Old Street for the exchange of traffic between the two companies; and a Bill has been deposited in Parliament by the Baker Street and Waterloo Electric Railway Company, now in

course of construction, for the extension of that line from Waterloo to join this company's railway at the Elephant and Castle Station. In accordance with the powers conferred on the company by the City and South London Railway Act of 1898, the half-year's dividend on the 5 per cent. perpetual preference shares, issued in 1896, will be charged to capital. The warrants for this and the other dividends will be posted on the 12th proximo. The directors who retire by rotation on this occasion are Mr. Sampson Hanbury and Mr. S. Barclay Heward, both of whom are eligible for re-election. Mr. James Lorimer Oliver is the retiring auditor and is eligible for re-election."

Great Northern and City Railway Company.

THE report of the directors for the half-year, ended 31st ult., submitted at the third half-yearly meeting held in London yesterday, 1st inst., states that the construction of the railway is actively proceeding, and, at the Regent's Canal, both the up and down line tunnels are making good progress. The shield chamber at Essex Road station is ready and the shield is in course of erection. Excavation of the tunnel at this point will shortly be commenced, and work has begun at Drayton Park. An arrangement has been made with the City and South London Railway for a joint station at Old Street.

The meeting of the company was held yesterday afternoon at Westminster Palace Hotel. A report will appear next week.

Stock Exchange Notice.—The Stock Exchange Committee has ordered the undermentioned securities to be quoted in the Official List:—Commercial Cable Company—Further issue of £230,255 4 per cent. 500-year debenture stock. Applications have also been made to the Committee to appoint a special settling day in:—Hampstead Electric Supply Company, Limited. —6,360 ordinary shares of £5 each, fully paid, Nos. 1 to 2,652, 2,853 to 4,416, and 4,471 to 6,614, 8,038 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 5,330, 5,431 to 6,000, 15,763 to 16,912, and 16,918 to 17,905, 5,433 vendors' ordinary shares of £5 each, fully paid, Nos. 6,615 to 12,047, and 9,862 vendors' 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 5,331 to 5,430 and 6,001 to 15,762.

London Electric Wire Company, Limited.—A meeting of this company was held at Winchester House on Tuesday last for the adoption of report and accounts, but the proceedings were conducted in private.

Westminster Electric Supply Corporation, Limited. —The directors recommend a dividend at the rate of 16 per cent. for the half-year ended December 31st, making with the interim dividend 13 per cent. for the year.

The British Electric Transformer Manufacturing Company, Limited.—The directors on Tuesday declared an interim dividend at the rate of 10 per cent. per annum for the six months ending December 31st, 1899. Dividend warrants will be posted on 9th inst.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending January 27th, 1900, were £149 16s. 0d.; receipts for corresponding period, 1899, £154 14s. 11d.; aggregate for half-year to date, £573 5s. 7d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending January 26th, 1900, were £2,697 5s. 1d.; **corresponding period**, 1899, £2,382 9s. 1d.; **increase, £314 16s. 0d.**

The City and South London Railway Company.—The receipts for the week ending January 28th, 1900, **were** £1,092; ditto January 29th, 1899, £1,134; decrease, £42. Total receipts for half-year, 1900, to date, £4,470; corresponding period, 1899, £4,516; decrease £46. **Miles open, 8¼**

The Dover Corporation Tramways.—The receipts for the week ending January 27th, 1900, **were** £151 6s. 5½d.; January 28th, 1899, £132 5s. 2d.; **increase,** £19 1s. 3½d. **Total receipts to date, 1900,** £606 9s. 0d.; **corresponding period, 1899,** £586 19s. 1d.; **increase,** £19 9s. 11d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,910; 1899, 4,247. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week **ending Friday,** January 26th, 1900, **were as follows:—D. U. T. Co., horse cars,** £87 8s. 6d.; **ditto, electric cars,** £2,537 10s. 3d.; **D. S. D. Co., electric cars,** £609 6s. 9d.; **total,** £3,534 5s. 6d.; **corresponding week last year—D. U. T. Co., horse cars,** £1,886 5s. 0d.; **ditto, electric cars,** £979 1s. 2d.; **D. S. D. Co., electric cars,** £620 1s. 0d.; **total,** £3,385 7s. 2d.; **increase,** £298 18s. 4d. **Aggregate to date,** £13,101 7s. 1d.; **aggregate to date last year,** £21,970 5s. 2d.; **increase to date,** £1,131 1s. 11d. **The mileage worked is 41 miles electrically, 3 miles by horses, as against 16 miles electrically, 28 miles by horses, for the corresponding period last year.**

The Halifax Corporation Tramways.—**The receipts for the week ending** January 21st, 1900, **were** £530; January 25th, 1899, £295; increase, £235. Number of cars, 1900, 28; 1899, 12. Total receipts to date, 1900, from April 1st, 1899, £24,949; 1899, from June 29th, 1898, £7,884. Week ending January 29th, 1900, £545; February 1st, 1899, £305; increase, £240. Total receipts to date, 1900, £25,494; 1898, £8,189. Miles of track open, 1900, 12; 1899, 3½.

The Liverpool Overhead Railway Company.—The receipts for the week ending January 28th, 1900, **amounted to** £1,571: **corresponding week last year** £1,258; **increase,** £313; total for half-year to date, £766.

The South Staffordshire Tramways Company.—The receipts for the week ending January 26th, 1900, **were** £733 15s. 6d.; January 27th 1899, £542 8s. 6d. Aggregate receipts for 4 weeks, £2,349 5s. 9d.; last year, £2,308 5s. 10d.

STOCKS AND SHARES.

Wednesday Evening.

THE highly-strung feeling of nervousness which is abroad in the general markets of the Stock Exchange finds but little reflex in the calm placidity of the electrical departments round the "House." The war—that dominant feature of the speculative sections—is gradually losing its hold upon the mind of the investor, who knows that it is only a question of time before the British take Pretoria and markets resume their normal attitudes. Certainly, the effect of hostilities hangs over a few quotations in the electrical departments, but it is so slight as to be scarcely perceptible. A glance at our list of prices shows what we mean: out of the 123 officially-quoted stocks and shares, less than a dozen are altered since last week, and of these, more than half are caused by the quoting of the securities *ex* dividend on the last account day, January 26th.

In the electrical railway market, City and South London stock has nominally fallen a point, but in reality the drop is worse than this, it being exceedingly difficult to find a buyer at anything like the current price. For this, of course, the reduced dividend which we announced last week is mainly responsible, but it must be remembered that for some time past the market in this stock has been next to nothing, and what dealing has taken place was in the nature of what the Stock Exchange calls a matter of negotiation. Waterloo and City Ordinary Stock keeps steady, and the report of the company speaks well for the relief which this little line affords to the congested traffic of the London streets. Central Londons do not move. The recently-published statements with regard to the electrifying of the two principal underground lines have not been sufficient to prevent a fall in the Ordinary stocks of both companies. Metropolitan Consolidated has dropped from 113 last Friday, to 112, and District Ordinary stock at 29½ is ⅝ below last week's price. It is rather interesting to note, in passing, that the last dividend paid on Districts was in August, 1882, 17½ years ago.

One solitary change has to be noted in the list of electricity supply companies. County of London and Brush Provincial Preference are 10s. down, otherwise there is no reportable alteration since last Wednesday. Business in this department has shrunk to unrecognisable dimensions, but the heavier shares stoutly maintain the advances which they secured a week ago. The St. James's and Pall Mall dividend and bonus are at the same rate as in 1899, and the market is anticipating similar results from the Westminster,* Notting Hill, and Metropolitan Companies. There is some doubt as to what the City of London directors will distribute, but expert opinion is going for a dividend of from 3 to 5 per cent. In almost every case the companies are doing excellent business, although the extravagant price which coal has now reached is militating against them, and is bound to tell sadly upon results. At the Smithfield Market meeting, which was held the other day, the chairman drew attention to the large amount of new business which is being obtained by the company. The shares are supposed to be buyers at 2, but we doubt whether a seller would be able to get as much if he wanted to dispose of his holding.

An advance of 30s. per share in the price of British Insulated Wire has been brought about by persistent inquiries for the shares in a market which is already short of them. Edison & Swan Ordinary have not improved upon their rise of last week, but the 4 per cent. Debenture stock is up 1 per cent., and as a speculative investment it is not unattractive.

Telegraph stocks and shares would be featureless were it not for the speculation that goes on around the Anglo-American group. Anglo "A" and "B" have both declined, and the Ordinary stock has shed a point. The stocks are largely influenced by outside influences, and the conduct of the war has kept all speculative markets depressed this week up to the time of writing. The "A" stock, be it noted, still carries the dividend of 27s. per cent., which will not be deducted until Friday next, February 9th. Eastern Extension Telegraph Ordinary has undergone no change, despite the discussion which was evoked by the spirited speech made by the chairman of the company, Lord Tweeddale, at the meeting last week. Globe Telegraph and Trust shares—both Ordinary and Preference—quickly recovered the dividends of 1s. 9d. and 3s. per share respectively, which were knocked off last Friday, but Direct United States Cable failed to do this, and allowing for the dividend, have fallen 2s. per share to 11⅜.

* Since declared 13 per cent., against 12 per cent. for 1898.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation, Jan. 24th.	Closing Quotation, Jan. 31st.	Business done during week ended Jan. 31st, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s	73/6	65 — 68	65 — 68	6⁻⅛	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	115 —116	115 —116	115⅝	114⅝
3,062,240	Do. do. Deferred	Stock	...	18s. %	£1 7s	17⅛— 17⅜	17 — 17⅛	17⅝	16¾
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	...	...	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,332,823£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	103¾	102⅝
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½%	1 %	...	⅛— ¼	⅛— ¼	...	...
16,000	Cuba Telegraph	10	7 %	8 %	...	8½— 9½	8½— 9½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	19 — 20	19 — 20	...	...
12,931	Direct Spanish Telegraph	5	4 %	...	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	101 —105%	101—105%	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	11¾— 12¼	11½— 12 xd	12	11½
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	153 —158	153 —158	158	153½
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	98 —101	99 —101	99	98⅞
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	115 —120	115 —120	117	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	...	15½— 15¾	15½— 15¾	15¾	15 5/16
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	99 —103	99 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	117 —122	117 —122	118	...
17,400	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red., Reg. Nos. 1 to 2,343	100	...	...	...	... ...	... ...	...	...
24,500	Do. do. do. to bearer, 2,344 to 5,500	100	...	...	...	... ...	... ...	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	...	...	...	101 —104	101 —104	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	...	...	...	101 —104%	101—104%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	...	11 — 11¼	11 — 11¼xd	11⅜	11¼
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½xd	15½	15 7/16
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	...	...	30 — 32	30 — 32	31	30½
86,300	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	49 — 53	49 — 53	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	106 —109	106 —109	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	...	...	¼— ⅛	¼— ⅛	...	...
86,492	Do. do. 5% Pref., Nos. 1 to 86,492	1	...	...	...	½— 1	½— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	...	5½— 5⅝	5½— 5⅝	5 11/16	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	14 — 15	14 — 15	14⅛	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14 — 15	14 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	...	5⅜— 5⅝	5⅜— 5⅝	5½	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	...	98 —100	98 —100	98⅝	98
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	½— 1	⅜— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	...	...	101 —104	101 —104	...	...
11,839	Reuter's	8	5 %	...	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	...	...
58,000	United River Plate Telephone	5	6 %	...	...	4⅜— 5¼	4⅜— 5¼	...	...
16,639	Do. do. 5 % Cum. Pref. Nos. 1—16,639	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	..	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	%	...	...	99 —102	98 —101	...	...
80,008	West Coast of America, Nos. 1—80,000 and 53,001—53,008	2½	...	...	...	⅛— 1	⅛— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	100 —104	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red.	Stock	...	...	...	100 —104	100 —104	100	...
205,993	Western Telegraph, Ltd., Nos. 1—205,993	10	...	...	...	... ...	14¾— 15¼	15 1/16	14 15/16
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	...	...	...	... ...	106 —109	...	...
88,321	West India and Panama Telegraph	10	8%	...	...	⅞— 1⅛	⅞— 1⅛	...	...
84,568	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	...	...	9¼— 9⅜	9¼— 9⅜	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	...	...	7 — 8	7 — 8	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	104 —107	104 —107	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds	100	6 %	...	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	...	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref.	5	7 %	...	...	8½— 9½	8½— 9½	...	...
30,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	...	10 — 11	10 — 11	...	...
20,000	Do. do. do. do. Nos. 30,001—50,000	5	...	...	...	9½— 10½	9½— 10½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
34,000	*Chelsea Electricity Supply, Ord.,	5	6 %	6 %	...	7½— 8½	7½— 8½	...	...
100,000	Do. do. do. % Deb. Stock Red.	Stock	4½%	...	...	109 —111	109 —111	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000	10	10 %	6 %	...	10½— 11½	10½— 11½	11½	11
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	13 — 14	13 — 14	13¾	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	...	9½— 10½	9½— 10½	..	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	13 — 14	12½— 13½	13	...
200,000	Do. 4½% Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	108 — 111	108 —111	108½	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	5 %	7 %	...	4¾— 5¼	4¾— 5¼	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	2 — 2½	2 — 2½	...	...
48,050	Do. do. do. 6 % Pref.	5	...	6 %	...	5 — 5½	5 — 5½	5	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	101 —103	100 —103	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	...	14½— 15½	14½— 15½	...	...
22,500	Do. Nos. 62,501 to 85,000	10	...	...	...	14 — 15	14 — 15	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	...	...	115 —117	115 —117	...	...
125,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	95 — 97	95 — 97	...	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	...	15½— 16½	15½— 16½	16½	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15½— 16½	15½— 16½	16	...
30,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	4 — 4½	4 — 4½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	12 %	13 %	14½— 15½	14½— 15½	15½	14½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Jan. 24th.	Closing Quotation Jan. 31st.	Business done during week ended Jan. 31st, 1900. Highest.	Lowest.
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	...	...	2⅜— 3¼	2⅜— 3¼	2⅞	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	6 %	...	16 — 17	16 — 17	16⅝	16½
30,000	Do. do. 6 % Cum. Pref. 30,001—60,000	10	...	...	...	13½— 13⅝	13½— 13⅝	13 9/16	13⅝
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	125 —128	125 —128	...	...
45,000l	†British Electric Works Co., Ord. £1 shares, 50,001—95,000	...	...	...	...	⅝— ¾	⅞— 1	...	...
50,000	† Do. do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	¾— ⅞	⅞— 1	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	...	...	...	11½— 12½	13 — 14	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	...	...	...	6 — 6½	6 — 6½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	3 %	5 %	...	1⅞— 2	1⅞— 2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	...	..
125,000l	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —115	110 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½%	15 %	...	13½— 14½	13½— 14½	...	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	5⅞	5⅝
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	110 —115	110 —115	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	9½— 10	9½— 10	10	9⅞
61,033	Do. do. Pref. half-shares	5	...	...	...	4½— 5	4½— 5	4¾	...
71,447	Do. do. Def. do.	5	...	...	...	4½— 5	4½— 5	...	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	59 — 62	58 — 61	60	59
37,000	Do. do. Ord. shares, Nos. 22,501 to 60,000 £5 10s. pd.	10	...	...	...	4½— 5½	4½— 5½	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3½— 4	3½— 4 xd	3⅞	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 —101	98 —101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	2 — 2⅛	2 — 2⅛	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	6 %	6 %	...	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	92 — 94	93 — 95	94	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	2 — 2⅛	2 — 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	...	2⅜— 3⅛	2⅜— 3⅛	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600l	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
30,300	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	...	13 — 14	13 — 14	13⅞	13⅝
12,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5½— 6	5½— 6	5¾	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	111 —114	111 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	22	...
800,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —104	100 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	...	8¼— 8½	9 5/16— 9 7/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	13 — 13¼	13 — 13¼	...	...
37,850	Telegraph Construction and Maintenance	12	15 %	15 %	...	36 — 40	37 — 41	38	36
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000 ...	5	...	...	...	9 — 10	9 — 10	...	...
20,000	Do. do. 5% Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½— 6	5½— 6	...	...
540,000l	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	101 —104	101 —104	...	...

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½% Debentures of £100, 102—104.
National Electric Free Wiring, 10s. paid, 5s.—7s.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 18—19.
Do. do. Pref. (£10 pd.), 10½—11.
Smithfield Market Electric, 1—2.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7½—7⅝. Debentures, 103—106. Dividend, 1898, on Ordinary Shares 10%.
Kidderminster and District Electric, Pref. (£6 pd.), 6—6½.
*T. Parker, £10 (fully paid), 18½.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (January 25th, 1900).

MARKET QUOTATIONS, Wednesday, January 31st.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a ,, Nitric .. .. .. per cwt.	22/-	22/-	..
a ,, Oxalic .. .. .. per cwt.	32/-	32/-	..
a ,, Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) .. per ton	£29	£29	..
a ,, ,, ... per ton	£27	£27	..
a Bleaching powder .. .. per ton	£7	£6 10	10s. inc.
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a ,, (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£24 10	£24 10	..
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a ,, White Sugar .. .. per ton	£31	£31	..
a ,, Peroxide .. .. .. per ton	£27 10	£27 10	..
Methylated Spirit .. .. .. per gal.	2/9	2/9	..
Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	4¼d.	4¼ l.	..
a ,, Caustic (75/80 %) .. per ton	£24	£24	..
a ,, Bisulphate .. .. per ton	£25	£25	..
a Shellac .. .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a ,, Recovered .. .. per ton	£5 10	£5 10	..
a ,, Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
Crystals .. .. .. per ton	£3	£3	..
a ,, Bichromate, casks .. per lb.	3¾ l.	3¾ l.	..
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£224	£224	..
b ,, Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£75 to £135	£75 to £135	..
c Brass (rolled metal 2" to 12") basis per lb.	8d.	8d.	..
c ,, Tube (brazed) .. .. per lb.	10d.	10d.	..
c ,, Wire, basis .. .. per lb.	8½d.	8½d.	..

METALS, &c. (*continued*).	This week.	Last week.	Inc. or Dec.
f Ebonite Rod .. .. .. per lb.	8/-	8/-	..
f ,, Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£82	£82	..
g ,, Wire (basis price) .. per lb.	10¾d.	10¾d.	..
g ,, Sheet .. .. .. per ton	£92	£92	..
g ,, Rod .. .. .. per ton	£82	£82	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	7/-	7/-	..
h India-rubber, Para fine .. per lb.	4/7 to 4/8	4/8½	dec.
i Iron, Charcoal Sheets .. .. per ton	£18.	£18.	..
i ,, Pig (Cleveland warrants) per ton	67/9	69/9	2s. dec.
i ,, Forgings, according to size per ton	From £11	From £11	..
i ,, Scrap, heavy .. .. per ton	70/- to 72½6	70/- to 72½6	..
i ,, Wire galvanised No. 6 .. per ton	£14 5	£14 5	..
g Lead, English Ingot .. .. per ton	£16 10	£16 2 6	7/6 inc.
g ,, Sheet .. .. per ton	£18	£18	..
m Manganin Wire No. 26.. .. per lb.	8/-	8/-	..
g Mercury .. .. .. per bottle	£9 12	£9 12 6	6d. dec.
d Mica (in original cases), small .. per lb.	2d. to 8d.	2d. to 8d.	..
d ,, ,, ,, medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large per lb.	3/6 to 7/6	3/6 to 7/6	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, r'l'd str'p & sheet per lb.	From 1/3½	From 1/3½	..
o Platinum .. .. per oz.	£3 11	£3 11	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/	10½d. to 1/	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £16	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£133	£124 10	£8 10 inc.
g ,, foil .. .. per lb.	nom.	nom.	..
n ,, wire Nos. 1 to 16 .. .. per lb.	1/9	1/9	..
p White Anti-friction Metals— "White Ant" brand .. per ton	1/10	1/10	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	£40 to £70	£40 to £70	..
j ,, Best Flax, 6 lea. .. per lb.	7¼d.	7¼ l.	..
j ,, Hemp, 3 ply 10 lbs. .. per lb.	5½ l.	5½d.	½d. inc.
j ,, Russian, 10 lbs. .. per lb.	4d.	3½d.	½d. inc.
j ,, Jute, 180 lbs. rove .. per ton	4¼ l.	4¼d.	½d. inc.
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£14 10	£14 10	..
	£26 5 nett.	£25 5 nett.	£1 inc.

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Fee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

SOME CONDITIONS AFFECTING THE MAINTENANCE OF CARS AND THEIR EQUIPMENTS.

[COMMUNICATED.]

If an English engineer were called on to estimate the probable *running costs* of the various divisions of a potential electric traction scheme, he could, without much difficulty, and with good chances of accuracy, foretell the amount with which to debit the power station; for making allowances for the considerably increased load factor, the decreased charge for switchboard attendants, and a few other betterments, his experience in the lighting school will guide him in estimating the cost of power at the switchboard. He can, moreover, pick up nuggets of information on this point from the gold mine of American and Continental statistics.

For similar reasons he will not be far out in estimating the cost of maintenance, depreciation, and "inefficiency factor" of the electrical construction beyond the board, including feeders, with their boxes, switches, manholes, &c., poles, and overhead wires, electrical and supporting.

He may, by good fortune, attain a fair approximation when dealing with the track, with its special work, bonding, and diverse ballasting—macadam, setts, or wood—but when he comes to the running cost of cars, he is face to face with a fearsome octopus, whose tentacles are hidden, towards which he advances cheerfully, grasping a sword forged from the mean of countless statistics.

If the engineer was born under a particularly lucky star, he may have struck a line which, in this matter of cars, will verify his estimate. With this line we have nothing to do, the object of the article being to indicate, however vaguely, some of the difficulties with which the question bristles, and which make the estimation so much a matter of chance.

The size of the outfit does not affect us particularly.

Expenses due to repairs and renewals should be merely nominal during the first six months. Everything is new, presumably in the pink of condition, and the contractors are, no doubt, hovering around, coaxing, and doctoring. It is after this critical period that the x's, the unknowns, the special characteristics of the men-in-charge of the line, of the cars and their equipments, begin to unfold themselves.

Let us attempt to marshal some of the unknowables:—

First, and most thickly veiled, comes the personal factor. However lusty a babe is electric lighting, electric traction is certainly yet "in its infancy" in Great Britain, and large type would be needed to fill a sheet of scribbling paper with the names of those who know a tramcar from a traction engine—speaking more or less figuratively. It is necessary, therefore, to imagine the possibility of the resident engineer being a man sound in lighting, but with an elemental acquaintance with the vices and surprises of a traction job. He may have been on some line where the conditions were ideal—and monotonous (for who would give anything for that job where the engineer could talk about "the even tenour of his way?" The man most likely to succeed is he who has been in charge of a system where breakdowns of every possible description—not due necessarily to bad management—come thick as leaves in—well, in Autumn).

This man has an unlimited capacity for learning, but—unfortunately for our estimator—a very small percentage of these surprises occur during the probation period of the undertaking, when the contractor's representative is at hand to advise; and so it happens, that instead of being able to strangle faults before birth they are allowed to develop fully, and only then is the preventative noted for use in future. In fact, the resident engineer has to learn by experience, which is likely to be a pretty penny out of the promoters' pockets.

Probably a more important place under the heading "Personal," should be assigned to the *motorman*—that most unspeakable product of devolution—for one must persist in counting him as belonging to a distinct genus, a race apart.

Who shall say beforehand what this uniformed wonder will do, or how he will do it; and who, when he considers what the motorman should know, would for a moment imagine that he *could* do it? In sooth, he should know all things, even as he knows the taste of beer. The contractors probably saw him through a period of skilled training; he is riddled with instructions as to what he should do under any circumstances; he has instruction books thrust upon him (sometimes with the adjuration that he read them as often as his Bible!); he has every chance to learn, and yet . . . .

Is there a particularly bad point entering a loop, then shall your motorman go through on the last notch—poor wheels, poor car—what recks he of broken flanges, of the terrible lurch on the lead, which twists the frame and strains horribly the car body; what cares he for the comfort of the passengers? All he cares about is to get a loop ahead of another of his kind. The damage to the car is not apparent at the time, so he will not suffer.

Is there a flooded place on the line? How fine to think that he can slosh through 6 inches of water, at the "making up" speed, without wetting his feet (oh! you wretched motors, arresters, and resistances). What a glorious device is the "emergency!" How it saves one's right arm to use that little handle to pull up for a passenger. If the passenger jumps on before the car has stopped, so much the better! Off goes the emergency, and nobody hears the ruinous arc inside. Look at the creature! He is climbing a hill when the current goes off—circuit-breaker out at the station. On goes the brake, and round goes the controller handle to the first notch, or maybe it remains where it was on the notch where the fields are shunted, the position which his "instructions" say "must on no account be used when climbing a grade;" then, when current again comes on, you see we start without loss of time, unless the station breaker opens at less than 200 amperes.

Look at him again. Something has caused his circuit-breaker to open time after time. What more natural than to hold the handle of that breaker until the depôt is reached, or perchance till the main fuse blows, in which case he is hopelessly stranded, because he has quite forgotten what he should do under the circumstances.

(How I love to see him step off a car to find what ails it when the lights go out, and it happens to be "grounded.")

All these things do not lengthen the life of the motor equipments. The motorman can damage a car in so many ways, and he uses his power.

Let us get away from the personal factor with all speed. After the engineer has learned that a car will not run an infinite number of miles without being overhauled—knowledge sometimes obtained at considerable cost—he institutes a regular system by which every car is run into the repair shed, either after travelling a certain number of miles, or some fixed period of time. After a little while he finds to his disgust that his orderly system works out better on paper than in practice, for cars apparently are not keeping the rules at all, but are just dropping into the repair shed when *they* like, not when *he* wishes. Armatures or field coils failing, brush-holder yokes burning up, controllers niggering, arresters short-circuiting, trolley connections continually earthing to poles, (oh! those delightful double-deckers) poles doubling up, axles breaking, wheels cracking, and flanges chipping off, trucks sprung out of square, and, finally, cars being dragged in with platforms wrecked, dashes and vestibules unrecognisable, controllers in smithereens, and broken glass everywhere. Most of these things happen occasionally on lines working under the best conditions, but it is doubtful if any engineer, with foresight of the brick-wall order, would allow for every one of these calamities happening continually on any one line. Yet these exaggerated evils are found on some—probably a very few—lines.

To show how such a concourse of disasters could come about, it will be well to indicate the possible conditions existing in one line. On the opening day everything runs smoothly; all things appear in order and well done. The track runs through a mining and manufacturing district, serving a dense and dirty population. In a few months some portions of the road begin to sink, owing to disused workings caving in. It subsides most quickly under the track, as all heavy traffic prefers the middle of the sett track to the softer macadam road sides. Joints open and sink, the track gets out of gauge, nasty kinks and curves are given to the rails. These things play havoc with wheels, axles, and springs. Setts rise and break low-hung gear, such as life-guards and gear-cases.

The road is very hilly, and the grades severe. Often, under ordinary conditions, the motors are running overloaded for 15 minutes continuously, and when a motorman has adjusted the brakes so that they bind on the wheels, this

overload is considerably increased. If the ninth notch (K, controllers are assumed) has not been removed it is probably used on this grade.

On a road which is hardly ever level, brakes may be on for half the round trip, which means that brake shoes require very frequent renewal, and much attention. On such a road 20 running cars will keep two men employed on little else than brakes. Moreover, on a greasy rail a bad driver will put a flat on a wheel in a remarkably short time, and being a bad driver, he will make it worse every time he slows up; consequently, the pair of wheels and their axle have to be taken out to allow the flats to be ground or turned out.

The locality is famous for its rain; all the low places on the track are flooded during wet weather, and much water finds its way into the motors. Certain types of arresters and resistances, unless well protected, are not at all fitted for a damp climate, and it is easy to surmise that the electrical equipment suffers much under the foregoing conditions. During the greater part of the winter dense white fogs prevail, and after most fogs, a car or two are found in the sheds, more or less damaged as the result of a collision, generally with heavy carts, the drivers of which are afflicted with incurable deafness; the heavier and slower the cart, the deafer is the driver.

In the summer the whole track is covered with a fine metallic dust, which finds its way into every part of the truck and car. Bearings run hot and melt out, thereby allowing the armatures to rub against pole faces. The life of every wearing part is lessened; and, until the bottoms of controllers are boxed in, the ravages of the dust increase the wages sheet considerably. Nor is it good for motors when the car runs over a rail insulated with dust every few yards with full current going on and off in jerks.

Snow is a "beautiful white devil" to the tramway man. In a manufacturing district its whiteness does not stay long, but it remains a devil throughout, and much salt mixed therewith is trying to things electrical.

The majority of these things have their cure, except the motorman, who is incurable. If proper precautions are taken, the occurrence of these mishaps is reduced to a minimum; but we have been considering the line on which the engineer has to learn from experience which he has not been able to gain elsewhere, who has to discover cures after the diseases have developed.

Perhaps it is plain now to those who did not know before, that for some indefinite period after the opening of a new system it is practically impossible to tell how much of the revenue is to be eaten up by "car equipments."

It is apparent that this article is a mere indication. Too little is seen in the technical papers of the experiences of traction men, and if this article should be the means of suggesting subjects on which others will expound, it will have served its purpose; and the writer may not have to subscribe so heavily to American traction organs.

A New German Electrical Monthly.—The *Centralblatt für Accumulatoren und Elementkunde*, edited by Dr. Franz Peters, of Charlottenburg, and published at Halle by William Knapp, has been started this year, and is to be devoted to the science and technique of primary and secondary batteries. No. 2 of this journal, which lies before us, contains some excellent articles. One on recent improvements of the Leclanché element, by I. Zacharias, describes a battery of this type invented by Pfannenberg, which is capable of giving 30 to 35 amperes on short circuit, and which, for 12 hours, gave a current commencing at 1·1 amperes and falling to 0·7 ampere. The improvement consists chiefly in increasing the zinc surface. We notice, also, excellent articles on the theory of the normal element by Dr. Jager, and experiments on the surface of accumulators for use in motor cars. The publication of a journal devoted to so restricted a section of the electrical field is characteristic of German specialisation. We have no doubt that the electrical profession will benefit by the special information supplied to them in so convenient a form, and we wish our new contemporary every success.

SOME SUGGESTIONS TO THE MANAGERS OF SMALL CENTRAL STATIONS.*

By GEO. HAYLER, Jun.

(*Concluded from page* 119.)

The question now arises, what is a fair rate? It is generally accepted throughout the eastern and central states that on meter measurement a basis rate of 20 cents per KW.-hour is about correct. Let us see for a moment how this compares with the price of gas. An ordinary gas jet consuming 5 cubic feet of very good gas per hour will, on the average, give from 18 to 20 C.P. A Welsbach lamp, when in good condition and consuming 3 feet of gas per hour, will give about 40 C.P. Then, 1,000 cubic feet of gas will produce with ordinary open-tip burners not to exceed 4,000 C.P.-hours, and with a Welsbach 13,300 C.P.-hours, or a little over three times as many. In order to produce the same amount of illumination with a 16-C.P. incandescent lamp, the lamp will have to burn respectively 250 and 832 hours. Assuming the consumption of an average lamp to be 60 watts, we should have to expend, in the first case, 15 KW.-hours, and in the second 50 KW.-hours. Now, if the price of gas is $2 per 1,000 feet, for an equivalent of light we shall have to sell 15 KW.-hours for $2, or at a rate of 13⅓ cents per KW.-hour, while in order to compete with Welsbachs we shall have to sell current at a rate of 4 cents per KW.-hour, a rate which is practically out of the question at small stations.

In the majority of small towns, however, light is sold on a contract basis, and we will consider briefly the advisability of modifying this system to the benefit of both the company and the consumer. From the records of our station I find that between the hour of starting the machinery and 10 o'clock p.m., the average number of hours run per month is 140. We can safely assume, then, that with contract lights the hours of burning will approximate this figure. Now, at 13⅓ cents per KW.-hour, a lamp burning for 140 hours, and taking 60 watts, will cost the consumer $1.12. If it is burned until 9 o'clock, or 112 hours per month, it will cost 89 cents, and if until 8 o'clock, or 84 hours, it will cost 66 cents. It would be out of the question, however, in most towns, to charge such prices for lights on contract, and it will be readily seen that for several reasons we can afford to make the rates much lower. In the first place, the customer having, say, 10 lights in his store, and closing at 9 p.m., would not, if they were on a meter, burn them for anywhere near 112 hours each month. This would be especially true in the summer time, when there would perhaps be no necessity for having them all turned on before 7 p.m. The result will be that, instead of paying $8.90 per month for his light, he will probably not pay more than $5.00. At the same time the cost to the company furnishing light would remain nearly constant; for interest charges, labour, &c., remaining nearly the same, the only difference would be in the cost of coal, wear and tear, &c., and this would be offset in a measure by the interest on the cost of meters, their maintenance and the advantages to be derived by avoiding disputed accounts. Again, if the customer is on a contract, he is bound to take light for a specified period, and in consequence the electric light company is assured of a certain definite revenue from him; while, perhaps, if he were on a meter he might take a notion to burn gas at times, and would prove a very unsatisfactory customer.

On the other hand, in competing with gas for the illumination of residences, public halls, churches, &c., requiring intermittent use of light, it is necessary to furnish an illumination equivalent to the gas—that as many or more electric lamps be installed as there are gas jets in use. It is necessary, also, that we make a rate comparable with the cost of gas for similar service. Obviously, then, the rate per lamp must be made much lower than in the case of strictly commercial lighting; if, now, we can assure ourselves that the lights will be used judiciously, or only when necessary, we can, perhaps, get a fair price for current furnished, but the chances are very much against such conditional affairs; and the consequence is, that there will be an enormous waste of light, for which the company will receive no compensation, and which waste will occur just at a time when the light has its maximum value to the producer. I know that in the case of the plant with which I am connected we passed through a similar experience. The load kept increasing until the capacity of our machines was strained, while at the same time the revenues remained unsatisfactory. A partial change to the meter basis—more especially in residence lighting, churches, public halls, &c.—resulted in cutting the load almost in two, while the revenues, after a temporary drop, soon increased again above what they were before the change was made.

I think, then, that in the case of small stations it is safe to say that for commercial customers, using perhaps up to as high as 10 or 15 lights almost constantly during lighting hours, the contract system is preferable. But in installations requiring a large number of lamps, where it is not necessary to burn them continually, the contract system results in a great waste of light; and in such cases the meter system is the best solution of the difficulty, and even this has its faults. Electric light has some features peculiar to itself which make it almost the ideal form of illumination. It is clean and cool, does not vitiate the atmosphere, and its quality is such as to make it particularly valuable for distinguishing colours at night. It also lends itself admirably to decorative effects, and can be used under circumstances where other forms of illumination are entirely out of the question. All of these advantages tend to make

* Read before the Ohio Electric Light Association, Cleveland. Mr. Hayler is manager of the Van Wert (O.) Electric Light and Power Company.

electric light bring a premium over the price charged for gas lighting for many purposes, and should be used as arguments in persuading customers to take light. Decorative lighting may seem a very unprofitable field in a small town, yet it is a good form of advertisement for the company. Window lighting is also a very profitable field, and although one would not expect much from this source in a small town, yet the revenue to be obtained from it is surprising. Handling electric and combination fixtures has also been the means of obtaining us many good customers. We do not attempt to make much profit out of the business, but try to do good work and please our customers, and the result is, that they very rarely leave us, after once experiencing the convenience of having electric light scattered freely throughout the house, and capable of being turned on and off without groping around in the dark to find a chandelier.

The second requirement for the increase of our net income is the reduction of operating expenses. This phase of the question has received so much attention lately, both in the columns of the technical papers and at the meetings of various lighting associations, that anything I might say would be simply repetition. The subject was handled most admirably at the last year's meeting of this association by Mr. E. P. Roberts in his paper, entitled "Positive and Negative Economies in the Operation of Small Electric Light Plants." If it were possible to emphasise any of his statements, I should first call attention to the necessity of keeping close account of everything that goes to make up the operating expenses. Keep books. It is not such a tremendous amount of work; and don't be satisfied with simply an account of receipts and expenditures. It is just as necessary for the manager of a small plant to know where his money is going as it is for the manager of a large plant. Keep daily station records of the number of hours run, the load in arc and incandescent lamps, the amount of water consumed, the amount of coal burned, and of the dozens of little and big things that go to make up the expense account. You would think your fireman crazy if you saw him shovelling dollar bills under the boiler, yet perhaps that is just what he is doing for you, only in another way. Weigh your coal and water once in a while, and see about what you are doing; perhaps your coal is unsuitable for the work required of it; perhaps your fireman does not know as much about firing as he should; check him up and see. You will be surprised at the amount of interest that your men at the station will take in these matters. If they are the right sort of men they are interested in your success, and are willing to do their best to help you if you can only tell them what to do.

Know the conditions thoroughly under which you are working, and then, knowing them, try to improve them to the best of your ability. You may have difficulty at times in raising the necessary money with which to make changes and improvements; but you do not need to make them all in a day; do it gradually. Rather than spend a little money in tinkering things up so that they will work for the time being, get at the root of the difficulty and fix it up once and for all, even if it does cost more.

Above all, avoid buying things on which your service depends because they are cheap. I do not mean to say that one should always buy the most expensive supplies, but he should use good judgment, and strive to buy the best and most suitable for his purpose.

And, finally, do not make the mistake of being too economical in your pay-roll. The labourer is worthy of his hire, and if you have a good man show your appreciation of him by paying him what he is worth to you.

In conclusion, I would say, study the conditions peculiar to your town and your plant; become familiar with every detail; get out once in a while and see your brother managers and have a chat with them and see what they are doing. Keep posted in current affairs in the electrical business, and strive to insure that your customers have as reliable service, as good light and as low prices as it is possible for you to give them.

ON THE PROTECTION OF ELECTRIC POWER TRANSMISSIONS FROM LIGHTNING.*

By J. T. MORRIS.

(*Continued from page* 95.)

The table appended gives a list of all the non-arcing metals known at the present time, together with their atomic weights and approximate melting and boiling points.

From these figures it will be observed that the melting points of these metals lie between 250° and 600° C. with the exception of mercury. These metals are all moderately fusible, and an examination of their boiling points will at once show that in the heat of the electric arc they will be instantly vaporised.

Now, by means of the vapour densities it has been shown that zinc, cadmium, and mercury have only one atom to the molecule when in the state of vapour, *i.e.*, they are monatomic, and this, probably, holds for the remaining metals. Consequently, their pure vapours are likely to be of very high resistance, owing to conduction by electrolysis being unable to take place.

* Paper read at a students' meeting of the Institution of Civil Engineers, February, 1898. Awarded a "Miller" prize.

Table of Non-Arcing Metals.

Name of element.	Symbol.	Atomic weight.	Melting point.	Boiling point.
Magnesium	Mg	24	600° C.	850° C.
Zinc	Zn	65	420°	940°
Cadmium	Cd	112	320°	750°
Antimony	Sb	120	600°	1,300°
Mercury	Hg	200	− 40°	360°
Lead	Pb	206	330°	...
Bismuth	Bi	208	270°	1,300°

The action of the non-arcing cylinders in the experiments previously described is probably to be explained as follows:—The zinc being vaporised by the arc; *when the air gap is small*, the pure vapour of the metal chokes up the air gap, and in virtue of its high resistance renders the arc very small and quiet when continuous currents are used; whilst, when alternate currents are used the arc is completely extinguished, because, as mentioned before, alternate current arcs are easier to interrupt owing to the current passing through zero many times a second, thereby giving the arc extin-

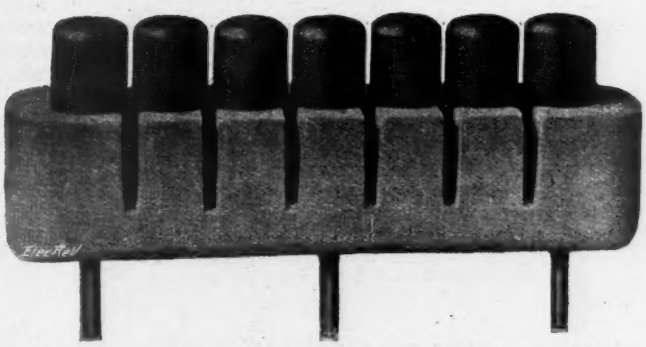
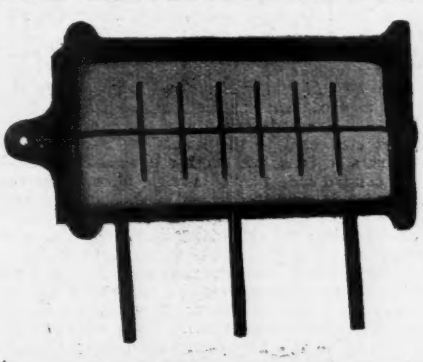


Fig. 25.—Wurts Alternate Current Non Arcing Metal Line Arrester.

Fig. 26.—Wurts Non-Arcing Metal Line Arrester.



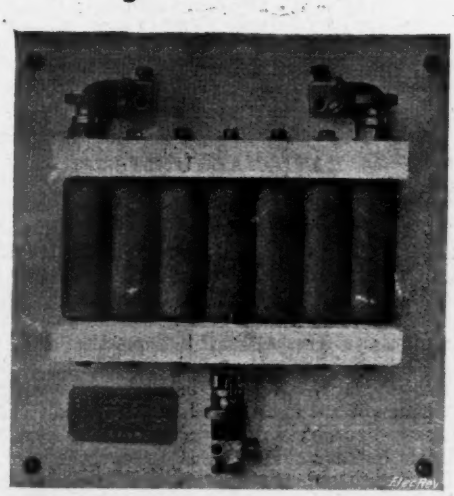


Fig. 27.—Wurts Non-Arcing Metal Station Arrester.

guisher a better chance of operating. *For longer air gaps*, the fact that the arc is maintained is probably due to the circumstance that air has much freer access, and hence largely reduces the resistance of the arc.

The foregoing principles are applied in the Wurts non-arcing metal lightning arrester, which is arranged in the following manner:—

Wurts Non-arcing Metal Lightning Arrester.—In the 1,000-volt arrester shown in figs. 25 and 26, there are seven solid

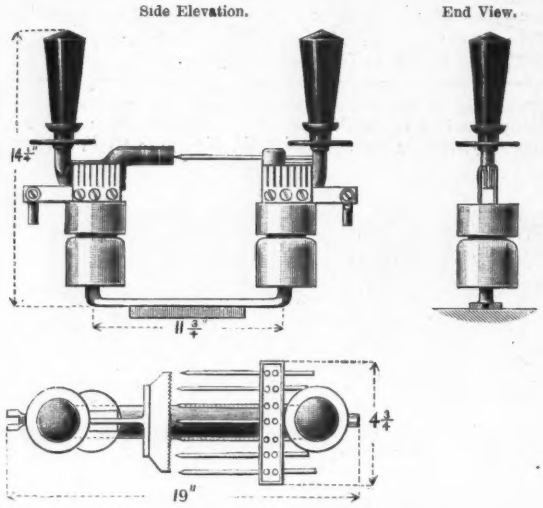


FIG. 28.—OERLIKON ZINC ROD LIGHTNING ARRESTER.

cylinders of an alloy of zinc and copper, each cylinder being 1 inch in diameter, and 3 inches long, and their surfaces are knurled. They are mounted side by side with their axes parallel, and are separated from one another by air-gaps of $\frac{1}{32}$ inch. The central cylinder is connected to earth, and the two outside ones to the two mains of the 1,000-volt circuit.

In fig. 27 is shown one of these arresters for station use. The line arrester only differs from it in being better adapted to withstand the weather in exposed situations.

These arresters are extensively used for protecting alternating circuits at the present time.

Oerlikon Zinc Rod Lightning Arrester.—The Oerlikon Company have recently introduced another arrester (see fig. 28) in which a number of pointed zinc rods are firmly clamped side by side in a metallic support connected to the line. The zinc rods, seven in number, are separated from one another by spaces of about half an inch, and their pointed ends face a metallic plate whose surface is grooved, and which is connected to earth by a short, straight, stout wire.

The air gap separating the zinc rods from the opposing corrugated surface is adjusted so that the normal voltage used on the line is in no danger of sparking over, but if an excessive difference of potential were to arise between the line and earth, a discharge would then take place over the arrester, and the line current would not follow owing to the non-arcing properties of the zinc. When, after numerous discharges, the ends of the rods have been wasted away, their distance from the opposing plate can again be set by means of the clamping screws in the support.

(To be continued.)

RATIONAL UNITS.

SEVERAL proposals have recently been made in France and America for changes in the nomenclature of the units of electrical measurement, and have been noticed in these columns. The object in view has been generally to give names to the fundamental units, and to devise a new system of names for the derived or practical units which shall indicate their relations to the fundamental. At the same time the body of opinion in England in favour of a reconstruction of the fundamental units is rapidly growing, and it seems possible that some steps may be taken to consider the question of a change.

So far as the requirements of practical engineers are concerned there is little to be said. They are already well suited. Their units are convenient, well understood, easily compared, and readily verified. They have nothing to gain from an alteration of their system comparable with the trouble and expense it would cause them.

With the scientific engineers the case is different. The labour of using and interpreting analytical expressions is less according as they express simple relations between definite physical quantities. The mechanical ideas of scientific men at the time that the B.A. system of electrical units was developed were largely based on the theory of attractions, and the mutual action at a distance of two similar quantities was their natural foundation. This mode of electrical action now rarely requires to be expressed, and the arguments and calculations now employed turn upon the conceptions of flux and circulation. Consequently the definitions chosen by the older men conveniently expressed the relations of electrical quantities considered as repelling and attracting one another, on a Newtonian law, but lead to inconvenient equations when used to express the properties of the electromagnetic field.

The proposals of Mr. Oliver Heaviside on this point are well known. They provide a system of definition very convenient for expressing the views of electrical action, whose acceptance owes much to himself. They have, however, this serious disadvantage, that they involve a change in the practical units.

The definitions of the B.A. units of the magnetic system are as follows:—

m	is the unit of	magnetism or unit pole.	
H	"	"	magnetic force.
B	"	"	flux.
M	"	"	current.
G	"	"	potential or gaussage.
S	"	"	permittance.
e	"	"	electricity or unit charge.
F	"	"	electric force.
D	"	"	displacement.
C	"	"	current.
E	"	"	potential or voltage.
R	"	"	resistance.

μ is the permeability of the air, k its sp. ind. cap. in magnetic units, so that $\mu k v^2 = 1$, where v is the velocity of light in air, L is 1 cm., d is 1 dyne, t is time in seconds.

These quantities are defined by the following relations:—

(1)	$m^2 = \mu \, \mathrm{L}^2 \, d.$	$e^2 = k \, \mathrm{L}^2 \, d.$
(2)	$m \, \mathrm{H} = d.$	$e \, \mathrm{F} = d$
(3)	$\mathrm{B} = \mu \, \mathrm{H}.$	$4 \pi \, \mathrm{D} = k \, \mathrm{F}.$
(4)	$4 \pi \, m =$ surf. int. B.	$e =$ surf. int. D.
(5)	$\mathrm{M} = d/dt \, . \, m$	$\mathrm{C} = d/dt \, . \, e.$
(6)	$\mathrm{G} =$ line int. H	E = line int. F.
(7)	$\mathrm{M \, S} = \mathrm{G}.$	$\mathrm{C \, R} = \mathrm{E}.$

(8) Two circuital equations $4 \pi \, \mathrm{M} = \mathrm{E}$, and $4 \pi \, \mathrm{C} = \mathrm{G}$

The presence of the coefficient 4π in the equations (3), (4) and (8) is inconvenient and inelegant. It does not indicate any real relation of the other quantities to circles or spheres, and obscures their true relations to one another. Mr. Heaviside dealt with this by changing the definition of the unit poles, writing the equations (1) in the form

$$(1) \qquad (\sqrt{4 \pi} \, m)^2 = m'^2 = 4 \pi \, \mu \, \mathrm{L}^2 \, d$$

and

$$(\sqrt{4 \pi} \, e)^2 = e'^2 = 4 \pi k \, l^2 \, d.$$

The unit pole, m', is now defined so that two unit poles at unit distance repel one another with a force 4π dynes, instead of one dyne in the B.A. system; and two unit charges repel one another with $4 \pi v^2$ dynes instead of v^2 dynes. As a consequence the unit pole becomes the source of unit flux, the unit charge the source of unit displacement. In the B.A. system the unit pole and the unit charge were the centres of unit force.

Writing for convenience 4π as x^2 the above equations may be put into the form—

(1)	$(x \, m')^2 = x^2 \, \mu \, \mathrm{L}^2 \, d.$	$(x \, e)^2 = x^2 \, k \, \mathrm{L}^2 \, d.$
(2)	$(x \, m) \, (\mathrm{B}/x) = d.$	$(x \, e) \, (\mathrm{F}/x) = d.$
(3)	$(\mathrm{B}/x) = \mu \, (\mathrm{H}/x).$	$(x \, \mathrm{D}) = k \, (\mathrm{F}/x).$
(4)	$(x \, m) =$ surf. int. $(\mathrm{B}/x).$	$(x \, e) =$ surf. int. $(x \, \mathrm{D}).$
(5)	$(x \, \mathrm{M}) = d/dt \, (x \, m).$	$(x \, \mathrm{C}) = d/dt \, (x \, e).$
(6)	$(\mathrm{G}/x) =$ line int. $(\mathrm{H}/x).$	$(\mathrm{F}/x) =$ line int. $(\mathrm{F}/x).$
(7)	$(x \, \mathrm{M}) \, (\mathrm{S}/x^2) = (\mathrm{G}/x).$	$(x \, \mathrm{C}) \, (\mathrm{R}/x^2) = \mathrm{E}/x$

(8) Two circuital equations $(x \, \mathrm{M}) = (\mathrm{E}/x)$: and $(x \, \mathrm{C}) = (\mathrm{G}/x)$.

Writing $m'/m = e'/e = \mathrm{M}'/\mathrm{M} = \mathrm{C}'/\mathrm{C} = \mathrm{D}'/\mathrm{D} = x$ or $\sqrt{4 \pi}$,

and $\mathrm{H}/\mathrm{H}' = \mathrm{B}/\mathrm{B}' = \mathrm{F}/\mathrm{F}' = \mathrm{G}/\mathrm{G}' = \mathrm{E}/\mathrm{E}' = x$ or $\sqrt{4 \pi}$,

and $\mathrm{S}/\mathrm{S}' = \mathrm{R}/\mathrm{R}' = x^2$ or 4π,

the above equations become—

(1)	$m'^2 = 4\pi\mu\,\text{L}^2\,d.$	$e'^2 = 4\pi k\,\text{L}^2\,d.$
(2)	$m'\,\text{H}' = d.$	$e'\,\text{F}' = d.$
(3)	$\text{B}' = \mu\,\text{H}'.$	$\text{D}' = k\,\text{F}'.$
(4)	$m' =$ surf. int. B'.	$e' =$ surf. int. D'.
(5)	$\text{M}' = d/dt\,m'.$	$\text{C}' = d/dt\,e'.$
(6)	G' = line int. B'.	E' = line int. F'.
(7)	$\text{M}'\,\text{S}' = \text{G}'.$	$\text{C}'\,\text{k}' = \text{E}'.$
(8)	and the circuital equations, $\text{M}' = \text{B}'$: and $\text{C}' = \text{G}'.$	

Mr. Heaviside calls these equations "rational," and the accented letters are the Heavisidal units. The coefficient 4π has been eliminated from all equations except (1) where it properly occurs. The objection to the system is to its interference with the established units in general use.

It has been suggested that if the notation of the permeability be altered as well as the definition of the unit pole, the equations may be brought into the "rational" form without changing the values of all the units. A suggestion of this kind was made in Prof. Rücker's letter, July, 1892, printed in Mr. Heaviside's collected papers, and within the last few weeks Prof. Fessenden and Prof. Fleming have made proposals on similar lines. It is easy to see what would be the effect of the combined changes.

Now let us call the permeability ν/q^2 instead of μ, and write $k = \kappa\,q^2$, so that $\mu\,k = \nu\,\kappa$. The original equations may now be written in the form

(1)	$(p\,q\,.\,m)^2 = p^2\,\nu\,\text{L}^2\,d.$	$(p/q\,.\,e)^2 = p^2\,\kappa\,\text{L}^2\,d.$
(2)	$(p\,q\,.\,m)(1/p\,q\ \text{H}) = d.$	$(p/q\,.\,e)(q/p\,.\,\text{F}) = d$
(3)	$(q/p\ \text{B}) = \nu\,(1/p\,q\,.\,\text{H}).$	$4\pi/p^2\ (p/q\,.\,\text{D}) = \kappa\,(q/p\,.\,\text{F}).$
(4)	$4\pi/p^2\ (p\,q\ m) =$ surf. int. $(q/p\,.\,\text{B}).$	$(p/q\ e) =$ surf. int. $(p/q\,.\,\text{D}).$
(5)	$(p\,q\,.\,\text{M}) = d/dt\,.\,(p\,q\,.\,m).$	$(p/q\,.\,\text{C}) = d/dt\,.\,(p/q\,.\,e).$
(6)	$(1/p\,q\,.\,\text{G}) =$ line int. $(1/p\,q\,.\,\text{H}).$	$(q/p\,.\,\text{E} =$ line int. $.(q/p\,.\,\text{F}).$
(7)	$(p\,q\,.\,\text{M})(1/p^2\,q^2\,.\,\text{S}) = (1/p\,q\,.\,\text{G}).$	$(p/q\,.\,\text{C})\,'q^2/p^2\,.\,\text{B}) = (q/p\,.\,\text{E}).$
(8)	$4\pi/p^2\ (p\,q\,.\,\text{M}) = (q/p\,.\,\text{E}):$ and	$4\pi/p^2\ (p/q\,.\,\text{C}) = (1/p\,q\,.\,\text{G}).$

Writing $p = q = \sqrt{4\pi}$, and

$$\frac{m''}{m} = \frac{\text{M}''}{\text{M}} = \frac{\text{H}}{\text{H}''} = \frac{\text{G}}{\text{G}''} = 4\pi, \text{ and } \frac{\text{S}}{\text{S}''} = 16\pi^2,$$

the equations become:—

(1)	$m''^2 = 4\pi\nu\,\text{L}^2\,d.$	$e^2 = 4\pi\kappa\,\text{L}^2\,d.$
(2)	$m''\,\text{H}'' = d.$	$e\,\text{F} = d.$
(3)	$\text{B} = \nu\,\text{H}''.$	$\text{D} = \kappa\,\text{F}.$
(4)	$m'' =$ surf. int B.	$e =$ surf. int. D.
(5)	$\text{M}'' = d/dt\,.\,m''.$	$\text{C} = d/dt\,.\,e.$
(6)	G'' = line int. H''.	E = line int. F.
(7)	$\text{M}''\,\text{S}'' = \text{G}''.$	$\text{C}\,\text{B} = \text{E}.$
(8)	and the circuital equations, $\text{M}'' = \text{B}$ and $\text{C} = \text{G}''.$	

Thus the system of equations is reduced to the "rational form" without changing the units of current, voltage, resistance, charge, electric force, flux or displacement. To the substitution of this for the present B.A. system it may be objected that, until a definite dynamical meaning can be assigned to μ and k by an acceptable theory of the mechanism of the ether, the whole system of measurement is to some extent a *modus vivendi*, and that tinkering with its exact form may be a waste of time and trouble. Considering, however, that this change would be of immediate value in science, without injuring its translation into the terms of engineering practice, and would not affect any commercial measures or apparatus, there is a strong *primâ faciê* case in favour of its adoption. W. A. P.

THIRD-RAIL CONDUCTORS.

The last number of *Cassier's Magazine* contains an article upon the above subject by Mr. Leo Daft—one of the earliest inventors and workers in the electric traction world. By the courtesy of the editor we are able to reproduce the accompanying illustration.

The article has considerable interest for those engaged in electric traction, first of all by showing what would be considered in this country and to-day outrageously rough construction work, although in 1885 it was thought pretty good for the United States. Mr. Daft gives a brief account of some early third-rail equipments near Baltimore, one such line (a photograph of which we reproduce) running for two miles on the side of a public road. What our Board of Trade, or the majority of the people using a similar roadway in this country, would think of the construction work shown in the photograph is, perhaps, best not stated.

Suffice it to say here, however, that it is just such lines of cheap construction along country roads (but, of course, using trolley wires rather than a third rail) that would benefit our agricultural interests enormously, and prove the salvation of an otherwise hopelessly decrepit and useless Light Railways Act.

There may doubtless have been special reasons for installing a third-rail system on the line mentioned by Mr. Daft, instead of using an overhead wire, but certainly some of the results must have been curious and amusing.

One would hardly have credited any driver of a horse

vehicle with voluntarily leaving the ordinary roadway to venture upon the line of rails where track construction was so free and untrammelled, but it was found necessary to put down guards on each side of the conductor rail, and Mr. Daft adds to our knowledge of animal instinct by citing some geese which belied their name and showed a great deal of sense—after getting a few shocks from crossing the line, one foot on the conductor and one on the damp earth—by persistently flying across not only these rails but all others!

They evidently intended to take no chances of finding out by painful experiment whether any particular rail was "alive" or not.

Old iron flat bottomed rails of 35 lbs. section were used for this conductor; and the surface was so corroded with rust that it had to be cleaned off by means of an emery wheel driven by a motor on the platform of a car and travelling slowly forward. Mr. Daft gives sketches of various forms of conductor, of specially rolled section. An ordinary or standard rail section he considers inadvisable, if only on account of its depth, which would raise it too high for crossings, &c. Consequently, he reduces the foot of the rail to mere edges, thickens the flange enormously, and makes the head more nearly rectangular.

In one case he installed a conductor which was simply a round bar of iron about 4 inches in diameter, in suitable grips or sockets, and on the top of it a longitudinal strip of bronze as the contact rail, slightly sunk or let into the iron bar, and fastened to it by means of screws flush with the upper surface.

It seems doubtful whether such a tempting show of what might be turned into money as scrap brass at so much per

pound would not be altogether too much for the honesty of the average tramp with a slight taste for mechanics, if such a system were used on any electric road at all accessible to wayfarers.

For insulating third-rail conductors, Mr. Daft strongly recommends strong porcelain insulators "single skirted" and with serrations on both sides, inserted between and secured to the cast-iron base, and the iron chair or umbrella carrying the conductor, by means of a metal alloy of lead-antimony-copper composition which slightly expands in cooling and so fixes the insulator firmly in place.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE meeting of the Institution of Electrical Engineers last week was held to continue the discussion on the report of the visit to Switzerland, and to hear a paper read by Mr. Sherard Cowper-Coles upon "An Electrolytic Centrifugal Process for the Production of Copper Tubes."

Prior to the ordinary business, the president, Prof. S. P. Thompson, made a touching reference to the death of Prof. Hughes. Announcements were made of the election of officers of the Dublin and Glasgow sections, the respective chairmen being Prof. G. F. Fitzgerald and Lord Kelvin, names received with acclamation by the meeting.

At the previous meeting, Mr. James Swinburne had at some length referred to the comparison of Swiss and English practice, and his remarks will be found of interest when given in full in the *Journal*. Mr. Ferranti was the first speaker at the last meeting, and he drove home the ease with which new ideas were taken up in Switzerland, having been struck particularly by the great facilities for doing all sorts of electrical work there. The customs of the country enabled people, or groups of people, to carry out considerable works in the way of development to the benefit of the country and the industry, and he regretted that in this country we did not seem to recognise how much progress was needed. Everybody there helped everybody else, but in this country terrible obstruction was met by everything new, and he impressed upon the meeting how much this "too terrible obstruction" had to do with the development of traction. Here we have very cheap coal and very good gas, the Swiss have dear coal and water-power easily developed in many cases, not in all. He was impressed by the complication of the central stations seen by the visitors. The generating part was as nice as could be, but there was often a "Chamber of Horrors" upstairs. The switching and handling was itself a big problem. The greatest objection was the complication of apparatus connected with the polyphase systems of supply. He cited Glasgow, and the immense mass of complicated and exceedingly expensive apparatus that had to be used. The ideas were fine, and results very good, but one wants to reduce complication and expense for distribution over very large areas.

Mr. E. K. Scott showed some instructive slides of Oerlikon locomotives and lines. Mr. M. B. Field referred to the expression by Mr. Crompton of surprise at the great simplicity of three-phase railway work. He showed how the stirrup assisted the overhead construction, as against the trolley in multiple. Some engineers, after visiting Switzerland, are apt to jump to a conclusion that traction work could be better equipped with three-phase motors than continuous series motors, but there are two well-defined classes of lines; for one of these three-phase is the best, and for the other series motors, while between them is an ill-defined region, partly one, and partly the other. The advantages of series motors, in many cases, show that everything is in favour of continuous current. Mountain railways have to admit the claims of three-phase altogether. The stations are often miles away from the lines, in inaccessible positions, and owing to the difficulty of attendance, transformers which require no oiling or starting up are decidedly the best. The stations are far apart. The risk of panic is reduced by three-phase motors, which directly limit the speed. It does not matter if the line is a little unsightly. It may be advantageous in some cases to supply the trolley line at 2,000 volts or 3,000 volts and transform down on the loco. The Central London line has, on the other hand, frequent stops, short runs, and requires great accelerations, so that the S.P. controller and series motors are undoubtedly the best. In three-phase work to get high accelerations it is probable that the power supplied would be wasted in rotor resistance. Before jumping to conclusions the alternative should be considered. In Switzerland the S.P. controller had not been developed, but they had advanced with three-phase work. They had the best three-phase, but had little cause to develop the series motor as in America, otherwise he would not have been surprised to find rotary converters in use there.

The next speaker gave some particulars to satisfy Mr. Hammond's desire for "costs." In few places was supply charged by meter. Usually a fixed charge of 20—25 francs per 16-C.P. lamp per annum was made. Motors were charged on a graduated scale, the price ranged from 200—250 francs, say, £8 or £10 per B.H.P. per annum for small sizes, up to for 50 B.H.P., 150—180 francs, say, £6—£7 per B.H.P. per annum installed, based on a working year of 3,000 hours. This worked out, say, at ½d. per B.H.P.-hour, which might be taken as representing 1 KW.-hour at the power house. In one exceptional case current was supplied for carbide manufacture as low as ¼d. per unit, but the financial and technical conditions were particularly favourable. He thought much too favourable an impression had been produced by three-phase plants. By dint of careful workmanship success had been attained, but it must be remembered that a continuous series motor would, at reduced pressure, run at a lower speed, but give its full torque, whereas in a three-phase motor the torque fell off roughly as the square of the pressure. Then Thomson's law could not be applied to the lines, as much drop of pressure must be avoided, otherwise the motors might refuse their work. It was also urged that higher pressures than 500 volts might be permitted on country lines.

Mr. A. P. Trotter emphasised the enormous importance of speed on the Central London line, and those like it. Of course, economy comes in, but there are many other considerations. He elaborated some of the points already mentioned in the course of the discussion. Mr. Addenbrooke referred to finance. In Germany the work had very largely been done by municipalities, and they had given the electrical business great importance. In this country they had weakened the business, and made it of as small importance as possible. On the Continent lines were often run for a series of years by one firm. That had resulted in very successful businesses, and the effect was that large German companies became very powerful and were in touch with the finance of the country. Mr. Addenbrooke then referred to the vexed question of centralised power houses as against localised stations, and gave a general *résumé* of the arguments in favour of each. Mr. Leon Gastner spoke on the importance of laboratories as training grounds and the assistance the technical schools rendered the electrical industry in Switzerland.

Mr. Mordey deduced as one of the lessons of the visit that we should have to look to Switzerland rather than to America for guidance in future practice. It seemed to be the one duty of some engineers to sell U.S.A. standard stuff, and this prejudicial influence was forcing people to adopt certain U.S.A. methods although they were admittedly obsolete. Many of the present Swiss complications will be swept away. Then there is the difference in business methods. The men controlling the works are practical men in Switzerland, this is why bankers support manufacturers. Again, there is a minimum of control by the authorities, and scientific institutions realise they are formed for the assistance of industry, while "they have not got consulting engineers, or, if they have, they are tame ones."

This closed the discussion, and Mr. Cowper-Coles followed with his paper. In the discussion on the latter a letter was read from Mr. Wilde, of Manchester, citing a patent of his for a similar process. Mr. Mordey briefly spoke, and Mr. Ferranti gave an account of two electrolytic processes he had seen on the Continent. Mr. Addenbrooke asked some questions, and the President referred to Matthiessen's copper standard and the Committee now sitting on the question. Mr. Cowper-Coles having briefly replied, the meeting adjourned.

THE COPPER MARKET AND COPPER MINING FINANCE IN 1899.

By JOHN B. C. KERSHAW, F.I.C.

The year 1899 has been an eventful year in the copper mining and allied industries, and not since 1889 when the French attempt to corner copper was made, have large consumers of the metal been subjected to such a period of anxiety. From the producer's standpoint, it is no doubt pleasing to witness the steady advance in selling value of the particular article or material in which he is interested; but those who do not happen to be financially concerned in the production, look with less enthusiasm upon such advances in price; and the large consumer is inclined to regard them with feelings akin to dismay. Everything depends upon the point of view—and from the electrical engineer's point of view, the year 1899 has been one of the most worrying years in his experience as regards the supply and price of one of the chief metals used in electrical work. In order to present a clear view of the movement of stocks and prices during 1899, the monthly figures from Messrs. H. R. Merton and Co.'s reports are given below in tabular form—the figures in the upper line being the prices of standard copper on the 31st of each month, and those in the lower line being the stocks of copper in England and France and afloat thereto from Chili and Australia upon the same dates.

Table I.—Prices and Stocks of Standard Copper in 1899

1898. Dec.	Jan.	Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
57/10	69/10	71/0	70/0	77/0	76/15	76/15	76/5	76/15	75/15	72/17	73/15	70/0
27,896	26,015	24,826	28,497	26,529	30,156	29,004	33,019	32,889	28,828	26,804	25,765	22,817

The great advance in the price of copper which occurred in January, 1899, and the prospects of a very heavy demand for the metal in connection with electric tramway construction schemes in England and elsewhere, led a group of American financiers to examine the chances of success for a repetition of the Paris experiment of 1889, and early in April the Amalgamated Copper Company was registered in New Jersey, U.S.A., with a capital of $75,000,000. Improving upon the plans of the Paris Syndicate of 1889, the promoter of the new attempt to create a corner in copper decided to regulate to some extent the output of the metal from the mines, and with this end in view the financial control of the Anaconda and Parott mines in Montana, U.S.A., was obtained. These mines are estimated to produce about 40 per cent. of the U.S.A. output of copper, and about 20 per cent. of the total world's supply of the metal. This interference with the natural relationship of supply and demand and with the independent management of two of the principal American mining companies at once produced the desired effect, and the price of copper quickly rose to £77 per ton on April 30th.

From that date there has been a gradual decline in price, and the year has closed with copper at £70 per ton for prompt delivery, and 10s. to 15s. lower for three months' warrants. This falling away from the maximum attained in April has occurred in spite of the reduced shipments of electrolytic copper from America, to England and other European countries; and even the purchases of standard copper in London on New York account, have failed to stop the break in price, which has become more and more marked during the latter part of the year. These re-shipments of standard copper from Swansea and Liverpool to New York amounting in six months to 9,888 tons, are an entirely new feature of the situation, and they are generally regarded as a mere financial dodge to maintain the London price, rather than as a sign of the inability of the American mines to supply the American demand. It is satisfactory to note that if this view be correct the American syndicate has signally failed to achieve the end in view. Had no increase in the supplies of copper from sources outside the control of the syndicate occurred, there would, however, have been a most decided shortage of copper in Europe, and prices would in that case have been influenced in the manner desired.

But most fortunately Australia and miscellaneous producing countries have been able to increase their output during 1899, and the aggregate supplies from these sources are 17,000 tons in excess of the corresponding figures for 1898. The total supplies from the different countries and the total deliveries for the years 1897, 1898, and 1899, as given in Messrs. H. R. Merton & Co.'s December circular, are presented in tabular form below, and these form an interesting comment upon the action of the New York syndicate during 1899.

Table II.—Total Supplies and Deliveries of Copper in the Period, 1897—1899

Year.	Supplies.						Deliveries
	North America.	Spain and Portugal.	Chili.	Australia.	Other countries.	Total.	
1897	180,363	25,029	21,760	11,100	33,482	221,734	224,696
1898	133,303	23,057	24,850	15,760	33,932	230,902	234,951
1899	112,650	23,557	24,850	19,700	46,868	227,625	222,816

The increased shipments from Australia and "other" countries, and the restricted demand for copper resulting from the high price, have thus saved the European consumer from the bad squeeze which the Amalgamated Copper Company, of New Jersey, had so kindly and thoughtfully prepared for him. In the opinion of most of those who have given attention to copper during the past 12 months, the danger of a corner in copper is now gone, and the collapse of the American syndicate is thought to be near at hand.

The high price to which copper had been forced early in 1899, naturally served the purpose of the company promoter, and during the past year the writer has examined the prospectuses of 13 new copper mining companies which have been registered in London with an aggregate capitalisation of £3,650,000. Details of these are given in Table III.

Table III.—New Mining Companies Registered in 1899.

Name of company.	Nominal capital.	Date of flotation.
Copper King Mining Company ...	£350,000	January.
Balla Balla Copper Mines	250,000	February.
Colonial Copper Corporation... ...	125,000	April.
Einasleigh Copper Mine	200,000	May.
Tablas Finana Copper Company ...	150,000	May.
Panuco Copper Company	500,000	May.
Lloyd Copper Company	250,000	May.
Copper Company of B. Columbia ...	100,000	June.
Ray Copper Mines	260,000	June.
Cordilla Copper Mines	120,000	July.
Mount Lyall Blocks Copper Corp'n	300,000	August.
Caledonia Copper Company	750,000	August.
Mount Chalmers Copper Mines ...	300,000	August.

It is exceedingly probable that the majority of these new companies are over-capitalised, and when the price of copper has dropped back to its normal level of £50 per ton, some of the newly opened mines will no doubt cease production. But for the present these new companies serve the purposes of the consumer, and as soon as they commence to produce copper in the estimated quantities, they are likely to have considerable influence upon the market.

That £3,655,000 fresh capital should be sunk in the copper mining industry in London in one year, shows how hopeless is the task which confronts the Amalgamated Copper Company of New Jersey; for it is obvious that the present capital of the syndicate is inadequate for maintaining the necessary control of the producing mines, and the prospects of any decisive increase are rapidly fading. When the syndicate was first formed, a capitalisation of $250,000,000 was spoken of as eventually probable.

The following extract from the issue of the *Financial Times* for December 19th, 1899, will show that the prospects of such an increase are daily becoming more remote:—

The fall in the prices of American copper stocks during the year has already been extremely heavy, and one of the greatest sufferers is the Amalgamated Copper Company itself. Only a comparatively small amount of the shares was subscribed for by the public, either in Europe or America, and it is estimated that the Standard Oil clique themselves hold no less than $60,000,000 of the $75,000,000 of shares created. It is believed also that their other holdings in the copper mining field total about $40,000,000, so that in all they are carrying some £20,000,000 of stock. This is no joke, even for such a powerful

combination, and yet they are not only entirely unable to control the production, but even to maintain the price and to force consumers freely into the market. The American banks are beginning now to throw copper shares upon the market, and it is calculated that one bank alone holds some $30,000,000 of Amalgamated shares. When the crisis which was threatened last week really comes about—and in our opinion it cannot be staved off much longer—one of the first collaterals to be thrown out will be Amalgamated. As the *Boston News Bureau* remarked the other day, the Amalgamated cannot go forward and make more shares of the same kind until the present shares are digested or floated, and when the black cloud of undigested Industrials hanging over Wall Street is spoken of, Amalgamated heads the list. Complaints have been made of late on this side that the Amalgamated interests are not supporting the copper market as they should do, but the probabilities are that they are finding the immense task they have undertaken a trifle too big even for their capacity. They have endeavoured unsuccessfully to corner copper, and have sunk millions upon millions in the undertaking. They are now being cornered themselves, and can scarcely escape without heavy loss. They will get no sympathy here, even though, fortunately, very little of the loss will fall upon ourselves. If we have escaped lightly it is, however, not due to any lack of effort on the part of the Combine bosses. They have endeavoured to dump copper on the European consumer at famine prices, and they have sought persistently to unload their inflated shares on the European investor. But we have gained wisdom from past experience, and we can now afford to stand by and watch the downfall of the gigantic house of cards they have built, with equanimity.

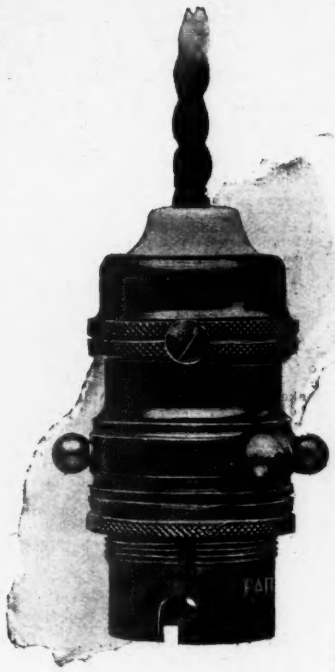
ELECTRICAL FITTINGS.

AT the Stellite Works, Aston, Birmingham, which were originally designed as a factory for cycles and cycle parts, the British Electric Works Company have lost no time in utilising and adapting the existing machinery for the manufacture of electrical fittings, with the result that the most modern automatic machines, with which the works are filled as closely as may be convenient for working, are now busy turning out the metal work of the various specialities of the firm. Samples of these have

been sent to us, and we have no hesitation in saying that they are well designed and well got up, while they embody many practical improvements both for the convenience of the user and for facilitating the work of the wiring contractor. We understand that the company will adhere to a number of standard articles, designing them to pass all reasonable requirements, so that by repetition work quality can be kept up while cost is kept down. The high voltage tumbler switch should satisfy the most fastidious requirements; porcelain bridges insulate the poles from each other and from the contact support. The contact surfaces are ample, and the shape of the contact bridge is well adapted to maintain a perfect contact. The insulation of the handle is thorough, and apparently it is impossible for the contact bridge to be in an intermediate position. In this switch is embodied a quick wiring device, which is also used in the ceiling roses and cut-outs. A half turn of an eccentric uncovers an opening in the contact pieces through which the lead is threaded—again a half turn and the wire is closely jammed, making a good contact, which will stand considerable rough usage. The saving in time is

almost incredible when compared with the older methods. One of the accompanying cuts shows the general design of the switch. The No. 1 Stellite ceiling rose is equally adapted for quick work, the flexibles can be wired in the shop, and with the cam action the work of fixing up is a matter of seconds. The Stellite lampholder is another example of labour saving—the above illustration shows its construction. The flexible wires are connected to the terminals, which drop into recessed sockets in the porcelain. The porcelain is shaped so as to form with a porcelain ring the cord grip held in position by the screwing down of the cap. We have wired one of these lampholders ourselves, and were surprised at the ease with which it could be done as compared with older types. We can quite support the maker's claim that three Stellites equal one ordinary holder as regards time of wiring. This lampholder is also made for use with fittings; various sizes of connections are stocked to suit the standard diameters of tubing. Of equally good workmanship is the switch lampholder, in which a half turn of the largest knob revolves an ebonite disc so as to bring the contact pieces into line with the pole-pieces above and the lamp terminals below. It is practically two lampholders, the lower part taking the lamp, the upper part making contact through the metal pieces in the ebonite, which is hollowed slightly downwards from the contact discs so as to allow of a quick break. The distance from metal to metal is ample, even in the intermediate positions for ordinary voltages, and apparently there is no reason why it should not satisfy the high voltage requirements. The British Electric Works Company

have also their own porcelain works, so that they are independent to a large degree of outside assistance, their boast being: We make



the porcelain, and we make the brass parts of British material with British labour.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS 1900.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

888. "A method of receiving, storing, and reproducing messages, signals, and the like, by magnetic influence upon magnetisable bodies." P. O. PEDERSEN. Dated January 15th.

892. "Improved trolley for overhead electric tramways." R. HUMPHRIES. Dated January 15th.

927. "Improvements in machinery for double wrapping and insulating electric cable wires." C. WILSON and J. MARRIOTT. Dated January 16th.

949. "Improvements in telephony." D. SINCLAIR. Dated January 16th.

95*a*. "Improvements in telephone apparatus." D. H. WILSON. Dated January 16th. (Complete.)

1,009. "Improvements in electrically or magnetically operated locks." C. B. MCCABE and L. GOUGHENOUR. Dated January 16th. (Complete.)

1,012. "Improvements in electricity meters." W. M. MORDEY and G. C. FRICKER. Dated January 16th.

1,022. "Improvements in the mounting of electric arc lamps." G. C. MARKS. (Continentale Jandus Electricitäts A. G. (Societe Anonyme), Belgium.) Dated January 16th.

1,024. "Improvements in electrical switches." S. H. HEYWOOD and H. W. HEYWOOD. Dated January 16th.

1,033. "Improvements in wiring electrical installations." F. BATHURST. Dated January 17th.

1,078. "Covering wires with insulating material for electrical purposes." H. A. KENT. Dated January 17th.

1,089. "Improvements in electrical conductors or cables." H. EDMUNDS. Dated January 17th.

1,100. "Improvements in electric motors and dynamos." W. LANGDON-DAVIES and A. SOAMES. Dated January 17th.

1,101. "Improvements in electric switching apparatus." W. F. JONES. Dated January 17th.

1,133. "Improvements in or relating to incandescent electric lamps." A. J. BOLT. (M. Sauvalle, France.) Dated January 18th. (Complete.)

1,147. "Improvements in electric motors for rotary dental tools and the like." P. JENSEN. (The Browning Manufacturing Company, United States.) Dated January 18th. (Complete.)

1,148. "An improvement in troughs for electric cables." SIEMENS BROS. AND CO., LIMITED, A. E. FOSTER, and H. J. NOTT. Dated January 18th. (Complete.)

1,159. "Improvements in telephone receivers." H. J. ROBSON. Dated January 18th.

1,160. "Improvements in or connected with dynamo-electric machines." A. J. PROTHEROE. Dated January 18th.

1,167. "A new or improved adjustable suspension device for electric lamps.' A. J. FABRE. Dated January 18th. (Complete.)

1,168. "Registering apparatus and circuits for telephone measured service. J. E. KINGSBURY. (The Western Electric Company, United States.) Dated January 18th.

1,170. "Automatic electric alarm." E. W. MOORE. Dated January 19th.

1,174. "The electric night light." A. R. TAYLOR. Dated January 19th.

1,245. "Improvements in arc lamps." J. D. F. ANDREWS. Dated January 20th.

1,267. "Improvements relating to permanent way for tramways and points therefor, specially applicable to electric tramways." J. A. BRODIE. Dated January 20th.

1,276. "Improvements in or relating to electric chain link-welding machines." A. J. BOLT. (La Société E. Giraud & Cie., France.) Dated January 20th.

1,284. "Improvements in electric switches." W. F. JONES. Dated January 20th.

1,297. "Improvements in conduits for underground pipes, mains, electric cables, and so forth." A. VICKERY. Dated January 20th.

1,309. "Improvements in the manufacture of compound tubes suitable for gas and electrical conductors," J. EARLE. Dated January 20th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1897.

7,868. "Improvements in electric clocks." F. Hope-Jones and G. B. Bowell. Dated March 26th, 1897. Relates to electric clocks. Improvements on the invention described in Specification No. 1,587, A.D. 1895. Two arrangements are described. (1) A pendulum detaches gravity detents from gravity impulse arms, and the latter in imparting their impulse complete the circuits of electro-magnets by contact with the lever armatures which consequently throw the gravity arms upon the detents again. The circuit includes a number of electro-magnetic indicators. Auxiliary electro-magnets acting on the detent may assist the re-passage of the gravity arms. (2) A clock movement (including escapement or pendulum or balance) is driven by a gravity or spring ratchet lever which sinks till it makes contact with the lever armature of an electro-magnet, which then throws it up again for another tooth of the ratchet wheel. Distant indicators are included in the same circuit as the electro-magnet of the independent clock. The ratchet wheel of an indicator has dog teeth of 90°, and the driving pawl acts horizontally at 45° from the horizontal diameter of the wheel while it also opens and closes a gap in the electric circuit. 6 claims.

7,870. "Improvements in or relating to dynamos or electric motors, and in apparatus for driving fans by electricity." J. W. Gibbs. Dated March 26th, 1897. Relates to the construction of dynamos and electric motors, and to the adaptation of the latter to the driving of fans. The armature and its appurtenances are placed inside the field-magnets and the poles of the latter are in the form of curved blades so as to permit of the machine being enclosed in a more or less cylindrical casing. The field cores are recessed to receive the windings so that the latter stand flush with the polar surfaces. The motor when applied for driving a fan is arranged in a framework, and the fan is so arranged as to draw a current of air through the motor for the purpose of ventilating it. Air enters through openings, and on entering takes a zig-zag course, so as to deposit dust; it is withdrawn through openings near the spindle immediately behind the fan. 4 claims.

7,877 "Improved apparatus for controlling and registering the time of working of electric lamps." H. H. Lake. Dated March 26th, 1897. Apparatus for controlling and registering the time of working of electric lamps. The switches control the current to the lamps, and the electro-magnets are in a shunt and receive current when a lamp is alight. These magnets control the wheel-work, the balance-wheel of which is so constructed that, through gearing it causes a drum to revolve once a minute. A number of spring rods rest against the drum and normally are slightly inclined, as shown in dotted lines, so as to avoid pins mounted on the drum. The rods are so connected to the switches by rods, that when one is turned "on" its corresponding rod is moved to engage one of the pins. At each revolution the end of a spring bar is forced outwards and strikes a cross-bar which is connected to a rocking lever and moves the wheel (connected to the indicator) one tooth. When two lamps are alight the frame is rocked twice per revolution, and so on. 1 claim.

7,955. "Improvements in the electric propulsion of vehicles and apparatus therefor." Siemens Bros. & Co., Limited. (Siemens & Halske.) Dated March 27th, 1897. On lines worked with alternating currents, the cars also carry continuous current dynamos and batteries so as to store energy under normal conditions, and to supplement the alternate current motors when necessary. 1 claim.

7,958. "Improvements in and connected with electric batteries." E. A. Jahncke. Dated March 27th, 1897. The plates which may be respectively zinc and lead, coppered lead, copper, or other materials, are suspended in pairs, except the end plates, from ledges by metal connections, and which have hook parts to engage the holes in the plates. The zinc plates are wrapped in vegetable parchment so that they can be placed close to the lead plates, and porous cells or partitions are dispensed with. The electrolyte, which may be copper sulphate, is run from the bottom of a closed reservoir into the cell, and the zinc sulphate formed, being of less specific gravity than the copper sulphate, is forced out of the cell through the perforated pipes or equivalents therefor and pipes into the reservoir. When the cell is not working, the electrolyte may be drawn off through a cock into the reservoir and is pumped back again through a tube when required. 6 claims.

8,041. "Apparatus for transmitting motion to a distance by means of electrical energy." Siemens Bros. & Co., Limited. (Siemens & Halske.) Dated March 29th, 1897. Relates to apparatus for transmitting motion in such a manner that perfect synchronism is obtained. If an alternating current flows through the fixed coils, an E.M.F. is developed in the movable coils; but as they are wound in opposite directions no current flows and no movement takes place. If now one pair of movable coils are moved the E.M.F. is varied and a current flows producing a movement of the coils in the other pair synchronously. In order to avoid dead centres several coils may be wound on each ring. The coils may be wound for simple alternating currents; where the transmitter and receiver are at some distance apart transformers may be interposed. A number of sets of apparatus may be arranged in parallel, and all working synchronously. The apparatus may be arranged to convert rotary into rectilinear motion or *vice versâ*. 2 claims.

8,048. "A new or improved method of regulating the pressure of electric circuits connected with primary or secondary batteries and apparatus therefor." L. W. Heath and J. H. Field. Dated March 29th, 1897. The current from primary or secondary batteries is regulated by the use of a supplementary battery or cells which can be placed in series with the main battery or with sections of the battery. The switch or combination of switches which is used is of such construction that the cells of the supplementary battery are first cut out or inserted, then a section of the battery is cut out, and the supplementary cells are inserted in series with the remaining sections and so on. The main battery is divided into sections of four cells, there being three supplementary cells connected between the contacts. A movement of an arm will cut in or out these regulating cells. This arm is mounted on a spindle gearing with the spindle of the contact arms. The gearing is so arranged that one revolution of the arm moves the arm from one contact to the next. The two contact arms serve to connect up the supplementary cells in parallel just previous to the cutting out of a section of the main. For charging the cells additional contacts or switches are arranged so that the main and supplementary cells can be charged together separately. 11 claims.

8,115. "Improvements in means for conducting electricity along railway trains for the purposes of communication and lighting." J. Taylor and J. E. Buckworth. Dated March 30th, 1897. The couplings for the vacuum or like brake tubes are fitted with electric contacts so that the electric conductors are coupled when the brake tubes are connected. The ends of the pipes are formed with coatings in which are fitted insulated spring contacts connected to the wires. The ear of each pipe is fitted with a projecting flange which forms a cover. The conductors are preferably bell, or similar circuits for communicating from the guard to the driver, or between the carriages and the guard's van, &c., and the conductors for the lighting circuit. In one arrangement, a bell and battery are arranged in the guard's van between the conductors and a bell on the engine on one of the wires. The wires form return wires and are connected with the wire only on the engine. Switches for completing the circuit between the wires are fitted in the carriages, &c. 3 claims.

8,131. "Improvements in primary electric batteries or generators." V. B. Esslok. Dated March 30th, 1897. One form of battery is shown in which the negative electrode which may be of copper forms also the outer cell of the element, within which the positive electrode is suspended by bolts from an insulating piece which also forms a cover for the cell. The electrolyte is preferably a mixture of 20 parts of water and 1 part each of sulphuric acid and copper sulphate. The cells are preferably placed in racks arranged in tiers in an external casing, and depolarisation is effected by heating them from below. To compensate for the evaporation of the electrolyte means are provided for ensuring an automatic supply of it to the cells, regulated by the level of the liquid in the cells. An electro-magnet is energised by the cell through a connection to an electrode and through a connection which is insulated from the negative electrode, connection with which is made through the electrolyte, so that when the liquid level falls below the connection the current is stopped. A train of wheels actuated by a motor operates a wheel and a supply cock. The train of wheels is prevented from rotating when either of the pins on the armature bears against the pin on the wheel, but at other times, when the armature is being drawn forward or is falling back, the wheels can rotate and liquid be supplied to the cell. 8 claims.

8,180. "Improvements in and pertaining to printing telegraphs, typewriters, and the like." W. L. Wise. (C. L. Buckingham.) Dated March 30th, 1897. Relates to apparatus for printing message in page form upon sheets of paper. The sheets of paper has two opposite edges pasted together to form a tube, and a row of perforations is made along the stiffened part formed by the overlapping edges. The invention consists mainly in apparatus for supporting and feeding the tube of paper. The specificatfon and the drawings deal with the electrical and mechanical details which are too protracted for the purposes of abridgment 32 claims.

8,185. "Improvements relating to the generation and distribution of alternating electric currents for light and power." J. Wetter. (Elektricitats-Aktiengesellshaft vormals Schuckert & Co.) Dated March 30th, 1897. Relates to means for distributing alternating currents to secure the advantages of single-phase currents for lighting, and polyphase currents for power. The armature of the generator has a main winding and a supplementary winding which produces a second phase lagging behind the first. There is a transformer for use with a polyphase motor and a lighting circuit, which is obtained from the outer wires only, and other arrangements or combinations are described. Instead of having a supplementary winding on the generator, motor generators having a supplementary winding may be arranged where desired in the circuit. Instead of having lamps and motors in the same circuit, the generator may have separate windings, one supplying lamp only and the other motors. In a further arrangement, the lamps and motor are arranged on separate circuits, each having three wires. To supply current according to the varying requirements of the service, supplementary generators are arranged at the station, and may be switched in parallel with the main conductors, or in parallel or series with the supplementary winding. 8 claims.

8,231. "Improvements in storage batteries." G. F. Redfern. (C. Riordon. Dated March 30th, 1897. Relates to secondary batteries. Each electrode is made up by helically winding a rectangular lead strip round a central grooved support, and packing in the spaces between the coils with oxide. From about the centre of the helix a conducting strip is led to one of the binding posts which have spherical heads; the posts in adjacent cells are connected by grooved plates and bolts. The supports are held in two insulating plates, of which one forms a cover for the cell. The upper ends of the supports are notched, and in the notches are held elastic bands, which are attached at their lower ends to pins, and serve both to hold the oxide in place and as separators. 12 claims.

8,295. "Improvements in or relating to electric traction and in apparatus employed therein." E. Vedovelli. Dated March 31st, 1897. Relates to a road contact or sectional conductor system with ground or overhead conductors and electromagnetic switches. Arrangements of the switch, circuits, &c., and the construction of the switches, collectors, conductors, road contacts, rail boards, &c., are shown in great detail which are too long for the purpose of abridgment. 21 claims.

8,416. "Improvements in electrical switches." W. J. Davy and G. T. Davies. Dated April 1st, 1897. The contact bar is mounted on a central spindle and a spring interposed between it and the base to prevent sagging at the centre of the bar. The handles are secured to the bar by screws and the position of the bar is adjusted by nuts. 3 claims.

8,563. "Improvements in connection with submarine cable laying appliances." C. S. Snell. Dated April 3rd, 1897. The cable instead of being arranged in tanks is wound on drums, and is delivered from the drum by means of an arrangement consisting of a circular guide carrying at its centre a rotating arm having a guide wheel and centrifugal balance weight. The vertical delivery wheel is mounted on springs and is connected by links with the rotating pressure brake. The cable is fed from a series of drums arranged so that two are in position for delivery. The end of the cable on one is connected to the beginning of the second, and the cable is led over a roller mounted on a rotating bracket provided with a spur, so that as the cable passes from one drum to the next the bracket is rotated and the cable cleared. The drums may be arranged on one or two decks in one, two, three or four rows so as to allow the full drums to be brought in turn to the delivery position, and the empty drums to be removed therefrom. 2 claims.

8,588. "Improvements in electrical resistance apparatus." H. A. Mavor, W. A. Coulson and S. Mavor. Dated April 3rd, 1897. A cast-iron or other conducting vessel contains a resisting liquid, and carries on a ledge a plate to which a terminal is secured. A second terminal and a sleeve connected with it are supported by insulating material in apertures in the plate, and the sleeve is threaded inside to carry a screw supporting a cast-iron or other electrode. The screw may be turned to raise the electrode and put resistance in circuit by an insulated hand wheel. The resistance is short circuited by contact of discs fixed on the screw with a socket on the plate, the discs and sockets may be dispensed with and the purpose effected by contact of the electrode with the bottom of the vessel. The vessel is provided with a cover, openings for the conductors, and an overflow pipe and may be supported on insulators. 3 claims.

8,602. "Improvements in electric lampholders and connectors." Veritys, Limited, and M. S. Cotterell. Dated April 5th, 1897. Relates to holders for incandescent lamps. A flanged cylindrical insulator is made with recesses extending into it from opposite ends of a diameter as shown. The insulator is also provided with two large holes in its lower end and two wire holes in its base. The recesses receive metal plates provided with binding screws for the wires, and with screwed holes to receive cylindrical plunger carriers. These are passed in through the holes and are slotted so that they can be screwed tightly against the base to fix the plates. The insulator is secured by its flange in an ordinary casing. Couplings such as wall plugs are constructed similarly. 3 claims.

8,663. "Improvements in dynamo-electric machines or electric motors." A. Holmes. (E. H. Johnson and R. Lundell.) Dated April 5th, 1897. Relates to continuous current dynamos and motors. A field magnet core consists of two similar steel castings, one being inverted relatively to the other. They are made with lugs and bolted together, forming a spherical casing having an elliptical opening in each end, and two pole pieces projecting inwards. The ends are bolted to discs cast with supports of any desired form, and cylindrical boxes, a conical extension being interposed on one. Openings in the discs below the shaft allow ventilation. The field winding is a ring placed as shown, conductors to it being passed through a bush. The armature shaft is carried in bearings secured in the boxes; these are closed by caps to hold oil, and oiling rings are placed on the shaft within slots, and pins on the bearings. The armature is thus removable without taking apart the field magnet. The commutator bars are clamped by a disc on a sleeve on the shaft. Carbon collecting blocks are pressed forward by springs in boxes clamped on lugs on the conical extension, with intervening insulation. Oil cups and sight holes for the oiling rings and commutators are provided. Specification No. 23,365, A.D. 1892, is referred to. 6 claims.

8,674. "Improvements in electric switches." A. C. Brockies. Dated April 5th, 1897. In a tumbler switch the movable contact is a U-shaped piece pivoted near its base by pins, and operated by a forked handle, engaging the ends of an insulated cross pin. A spring is arranged on each side of the contact to pull it on or off. The handle is supported in a bridge piece. This construction is applicable to rocking switches. 4 claims.

8,725. "Art of and apparatus for generating and distributing music electrically." R. A. Sloan. (T. Cahill.) Dated April 6th, 1897. Relates to a novel form of instrument in which electrical pulsations produced in making and breaking electrical circuits are first transformed into undulations approximating in form to sine curves, and are then rendered as musical sounds by a special form of telephone receiver. The apparatus consists in a set of 12 shafts rotated by suitable gearing at speeds corresponding to the 12 notes of the chromatic scale, each shaft carrying rotary contact breakers. The construction of one of the contact breakers with its electrical connections consists of a metal cylinder divided into transverse sections, and each transverse section is divided into longitudinal insulating and conducting sections the number of which corresponds to the vibration frequencies of the first six partials of the note corresponding to which the contact breaker stands. In the case of the higher notes less than six transverse sections are used. Parallel currents sent through the sections of a contact breaker from a dynamo thus get interrupted a number of times corresponding to the number of vibrations in the partials of such note, and these currents being received by a suitable telephone receiver form the note in question. The contacts between the contact breakers and the wires are formed by brushes, and any of the ordinary devices may be used to prevent sparking. The main circuit and line wire are both closed by keys arranged like those of a piano or organ. To produce pianoforte effects coils can be made to approach or recede according to the power applied to the keys. A coil is carried in a core which is struck by a hammer controlled by the key and the blow of which is proportioned to the power applied thereto. The receiving device consists of a number of telephone receivers having in place of separate diaphragms one or more large soundboards, like the soundboard of a piano. Instead of generating the main electric circuit by a single dynamo, the contact breakers may be used as armatures rotating in the neighbourhood of magnets surrounded by coils in which currents are thus generated. 231 claims.

8,809. "Improvements in and relating to telegraphic transmitting and receiving apparatus." B. Hoffmann. Dated April 6th, 1897. Relates to improvements in the class of apparatus described in Specification No. 24,076, A.D. 1894. The apparatus at one station is described by keys being depressed for transmitting. At the receiving station one key is raised, while if telephones are to be employed in place of the telegraphic apparatus, both keys are raised, thus connecting the line terminals to the telephone terminals. The main motor shaft carries a type wheel, escape wheel, vibrator wheel, and a distributor arm. The two distributor brushes are connected to collector rings on the shaft rubbed by two brushes. The distributor contacts of a ring are connected to the keys of the board, and these are arranged alternately to close or open the circuit; thus, the depression of a key produces either three consecutive closed keys or three consecutive open circuit keys. The sequence of intermittent currents control the escapement through a lever and armature of the two magnets, and at the same time prevent the vibrator spring from closing the contact in the local circuit. As soon as the sequence is broken by the depression of a key, the local circuit is closed and the printing magnet is excited, thus bringing the paper against the type-wheel. The type-wheel has two sets of characters set alternately, and is provided with two stop pins and a tripping device by which either set of characters can be brought to the printing position. The paper is fed between a corrugated roller and a guide fork, this roller being rotated by a ratchet wheel and fixed spring pawl to produce a feed after printing each sign. The distributor ring and key are employed in bringing the apparatus to unison at any time; the key when depressed reverses the current and brings the leading distributor to a stop at the unison position; should the two not then start together a second depression ensures unison. An accessory is described in which the key is provided with a conducting tip and two extra springs connected to the ring and a rotating make and break operated through half a space by a wiper pawl on the shaft. 8 claims.

8,885. "Improvements in hand-fed focussing electric lamps." J. E. Barnard and T. A. B. Carver. Dated April 7th, 1897. Hand regulated focussing lamps for magic lanterns or like purposes are so constructed that the carbons are carried by insulated holders on both slides. These slide on two parallel rods carried by a block which is clamped pivotally to a support attached to the lantern. The slides engage oppositely threaded parts of a screw for regulating the length of the arc. The screw is supported by a bearing, which slides on the rods and is movable along them by a second screw turning in the block to adjust the position of the arc. To facilitate regulation, an image of the arc is thrown on a marked screen by a small hole in a plate, these parts being carried by an arm clamped adjustably on the support. 2 claims.

8,906. "Improvements in electric couplings." W. J. Davy and G. T. Davies. Dated April 7th, 1897. Couplings for arc and other lamps that have to be raised or lowered. The hood or mantle is screwed to the supporting arm or bracket and is fitted with a flange to which an insulating block is secured. The block carries two concentric conducting rings to which the conductors are connected, they also carry depending spring contacts. On the top of the lamp is fitted another disc fitted with concentric rings adapted when the lamp is raised by the cord to engage a spring, these rings are connected to the lamp terminals. The cord is connected to an insulating block which passes through an opening in the upper disc and so forms a guide. The pulley is fitted within the mantle and the cord passes through an inclined tube to prevent the ingress of rain. In a modified form the helical springs are replaced by curved plate springs, and additional elasticity may be given by mounting the disc on springs. 2 claims.

8,970. "Improvements in electrical indicating apparatus, and in couplings used in connection therewith as a system for electrical communication." R. S. Hampson. Dated April 8th, 1897. Relates to an electric bell and bell indicator system for communicating between the different carriages of a railway train, &c., or between parts of a ship, &c. In the form of indicator employed the flag or disc, &c., being normally locked in its non-indicating position by the catch on the armature and by a second catch on the rod to prevent its displacement by vibration. When the bell circuit is completed the electro-magnet is energised, and releases the flag, &c. The flag is reset by means of the slide. The invention is described as applied for communicating between the passenger carriages of a railway train and a buffet car. An indicator in the buffet car shows the carriage from which the signal was transmitted, and an indicator in the carriage shows the compartment requiring attention. 3 claims.

9,166. "A method of and apparatus for erecting overhead electric conductors for railways and tramways." Dr. J. Werther and A. Schaffer. Dated April 10th, 1897. The overhead conductor to be strained is fixed at one end and is carried by a drum mounted on a trolley. The trolley is provided with ladder supports surmounted with a guide roller. The trolley is secured to the track by gripping jaws and is provided with loose brake blocks. The conductor is strained by a hauling chain and gripping jaws. A second trolley or ladder with holding jaws is moved up to the trolley after the conductor is strained, and the trolley is then moved off a further span. 2 claims.

ERRATUM.—ELECTRICAL REVIEW, No. 1,155, page 80, Abstracts of Published Specifications, for 20,180 read 29,180.